Draft EA

Programmatic Environmental Assessment of the Use of Well Stimulation Treatments on the Southern California Outer Continental Shelf

Prepared by Argonne National Laboratory
February 2016

Bureau of Safety and Environmental Enforcement, Pacific OCS Region
and
Bureau of Ocean Energy Management, Pacific OCS Region

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NOTATION

The following is a list of acronyms, abbreviations, and units of measure used in this document. Some acronyms used only in tables may be defined only in those tables.

GENERAL ACRONYMS AND ABBREVIATIONS

APD	application for permit to drill
API	American Petroleum Institute
APM	application for permit to modify
AQRV	
ARB	Air Resources Board
ATCM	Airborne Toxic Control Measure
BOEM	Bureau of Ocean Energy Management
BOP	blowout preventer
BSEE	Bureau of Safety and Environmental Enforcement
CAA	Clean Air Act
CAAA	Clean Air Act Amendments
CAAQS	California Ambient Air Quality Standards
CCAA	California Clean Air Act
CCC	California Coastal Commission
CCST	California Council on Science and Technology
CDFW	California Department of Fish and Wildlife
CEQ	Council on Environmental Quality
CFR	*Code of Federal Regulations*
CMLPAI	California Marine Life Protection Act Initiative
COA	corresponding onshore area
CPFV	commercial passenger fishing vessel
CT	crystobalite/tridymite
CWA	Clean Water Act
DFIT	Diagnostic Fracture Injection Test
DOE	U.S. Department of Energy
DOGGR	Division of Oil, Gas, and Geothermal Resources
DOI	U.S. Department of the Interior
DMR	Discharge Monitoring Report
DPM	diesel particulate matter
DPS	distinct population segment
EA	environmental assessment
EC_{50}	exposure concentration, toxic response in 50% of test organisms
EDS	Endangered Species Act

EEZ	exclusive economic zone
EFH	essential fish habitat
EIS	environmental impact statement
E.O.	Executive Order
EOR	enhanced oil recovery
EPA	U.S. Environmental Protection Agency
ESA	Endangered Species Act of 1972
ESU	evolutionarily significant unit
eWell	eWell Permitting and Reporting System
FCMA	Fishery Conservation and Management Act of 1976
FMP	Fishery Management Plan
FR	*Federal Register*
GHG	greenhouse gas
GIS	geographic information system
GWP	global warming potential
GWPC	Ground Water Protection Council
HAPC	habitat area of particular concern
IOGCC	Interstate Oil and Gas Compact Commission
LC_{50}	lethal concentration, 50% of test organisms
MBTA	Migratory Bird Treaty Act
MMPA	Marine Mammal Protection Act
MPA	Marine Protected Area
NAAQS	National Ambient Air Quality Standards
NCDC	National Climatic Data Center
NEPA	National Environmental Policy Act
NERR	national estuarine research reserve
NHPA	National Historic Preservation Act
NMFS	National Marine Fisheries Service
NMS	national marine sanctuary
NOAA	National Oceanic and Atmospheric Administration
NP	national park
NPDES	National Pollutant Discharge Elimination System
NRHP	*National Register of Historic Places*
NTL	Notice to Lessee
NWR	national wildlife refuge
O&G	oil and gas
OCS	Outer Continental Shelf
OCSLA	Outer Continental Shelf Lands Act

OPD	Office of Production and Development
PFMC	Pacific Fishery Management Council
PM	particulate matter
PM_{10}	particulate matter less than 10 microns in diameter
$PM_{2.5}$	fine particulates less than 2.5 microns in diameter
POTW	publicly owned treatment works
PSD	prevention of significant deterioration
PSV	platform supply vessel
PXP	Plains Exploration and Development Company
ROG	reactive organic gas
SB-4	State of California Senate Bill No. 4
SBCAPCD	Santa Barbara County Air Pollution Control District
SCAQMD	South Coast Air Quality Management District
SCB	Southern California Bight
SCS	southern California steelhead
SCSN	Southern California Seismic Network
SMCA	state marine conservation area
SMR	state marine reserve
SPE	Society of Petroleum Engineers
spp.	species
U.S.C.	*United States Code*
USCG	U.S. Coast Guard
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
VCAPCD	Ventura County Air Pollution and Control District
VOC	volatile organic compound
WA	wilderness area
WET	whole effluent toxicity
WST	well stimulation treatment

CHEMICALS

AMPS	2-acrylamido-2-methylpropane sulfonic acid copolymer
BTEX	benzene, toluene, ethylbenzene, and xylene
CH_4	methane
CMIT	5-chloro-2-methyl-3(2H)-isothiazolone
CO	carbon monoxide
CO_2	carbon dioxide

CO_2e	carbon dioxide equivalent
DDT	dichlorodiphenyltrichloroethane
EC	elemental carbon
H_2S	hydrogen sulfide
H_3BO_3	boric acid
HCl	hydrochloric acid
HF	hydrofluoric acid
HFCs	hydrofluorocarbons
KCl	potassium chloride
N_2O	nitrous oxide
NF_3	nitrogen trifluoride
NO_2	nitrogen dioxide
NO_x	nitrogen oxides
O_3	ozone
OC	organic carbon
PAH	polyaromatic hydrocarbon
PAM	polyacrylamide
Pb	lead
PCB	polychlorinated biphenyl
PFC	perfluorocarbon
SF_6	sulfur hexafluoride
SiO_2	quartz, silicon dioxide
SO_2	sulfur dioxide
SO_x	sulfur oxides

UNITS OF MEASURE

µm	micron
µg/m^3	micrograms per cubic meter
ac	acre
Bbbl	billion barrels
bbl	barrel(s)
C	Celsius
cm	centimeter(s)
F	Fahrenheit
ft	foot (feet)
g	gram(s)
gal	gallon(s)
hr	hour(s)
in.	inch(es)
km	kilometer(s)
km^2	square kilometer(s)
L	liter(s)
lb	pound
m	meter(s)
m^3	cubic meter(s)
mg	milligram(s)
mi	mile(s)
mi^2	square mile(s)
min	minute(s)
mm	millimeter(s)
MMT	million metric ton(s)
mph	mile(s) per hour
mt	metric ton(s)
ppb	parts per billion
ppm	parts per million
Tcf	trillion cubic feet
yr	year(s)

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EXECUTIVE SUMMARY

ES.1 INTRODUCTION

The Bureau of Safety and Environmental Enforcement (BSEE) and Bureau of Ocean Energy Management (BOEM) propose to allow the use of selected well stimulation treatments (WSTs) on the 43 current active leases and 23 operating platforms on the Southern California Outer Continental Shelf (OCS). Use of some WSTs may allow lessees to recover hydrocarbon resources (i.e., oil) that would otherwise not be recovered from the reservoirs in the lease areas that have been and continue to be accessed by existing wells as well as any new wells in the foreseeable future.

In accordance with the National Environmental Policy Act (NEPA) of 1969, BSEE and BOEM prepared this draft environmental assessment (EA) to evaluate the potential environmental impacts of the proposed approval of the use of WSTs on the 23 platforms currently in operation on the Southern California OCS Planning Area. This draft EA analyzes the potential environmental effects of WSTs under various alternative actions that would meet the purpose and need for the proposed action.

ES.2 PURPOSE AND NEED FOR THE PROPOSED ACTION

The purpose and need for the proposed action, to allow the use of certain WSTs (e.g., hydraulic fracturing) in support of oil production at platforms on the Pacific OCS, are to carry out BSEE and BOEM's responsibilities under the Outer Continental Shelf Lands Act (OCSLA) for effectively managing resources on the Federal OCS. Under the OCSLA, the Secretary of the Interior is required to establish policies and procedures that expedite exploration and development of the OCS for the production of resources (e.g., oil and natural gas) and to balance resource development with protection of the human, marine, and coastal environments, while simultaneously ensuring that the public receives an equitable return for these resources.

ES.3 PROPOSED ACTION AND ALTERNATIVES

The WSTs evaluated in this EA include fracturing and non-fracturing treatments which may be used for enhancing production from existing or new wells where formation permeability and decreasing reservoir pressure are limiting oil recovery. This EA adopts the definitions that are found in State of California Senate Bill No. 4 (SB-4) Oil and Gas: Well Stimulation. The SB-4 definitions are applied to WST activities that are occurring in State waters and accessing the same formations as those being accessed by offshore platforms on the 43 active Federal lease areas, as well as being widely used on land in California. Adopting the SB-4 definitions allows for straightforward comparisons of WST applications in Federal and State offshore operations and in the analysis of the cumulative effects of all offshore operations.

Under the SB-4 definitions, *Well Stimulation Treatment* means any treatment of a well designed to enhance oil and gas production or recovery by increasing the permeability of the formation. WSTs include, but are not limited to, hydraulic fracturing treatments and acid well stimulations. Routine well cleanout work, routine well maintenance, routine removal of formation damage due to drilling, bottom hole pressure surveys, and routine activities that do not affect the integrity of the well or the formation are not considered WSTs.

This EA distinguishes between “fracturing WSTs,” in which WST fluids are injected at pressures required to fracture the formation (i.e., greater than the formation fracture pressure), and “non-fracturing WSTs,” in which the WST fluid is injected at less than the pressure required to hydraulically fracture the formation. Diagnostic fracture injection tests (DFITs), hydraulic fracturing, and acid fracturing are the fracturing WSTs analyzed in this EA. Matrix acidizing is the only non-fracturing WST analyzed. The four WSTs analyzed in this EA are described as follows:

- **Diagnostic Fracture Injection Test (DFIT).** The DFIT is used to estimate key reservoir properties and parameters that are needed to optimize a main fracture job. It is a short duration procedure that involves the injection of typically less than 100 barrels of fracturing fluid at pressures high enough to initiate a fracture. Key parameters are estimated from the fluid volume injected and the pressure dissipation profile. The fluid used in a DFIT is typically the fluid that would be used in the main fracture treatment but with no proppant[1] added, thus allowing the fracture to close naturally as pressure is released.

- **Hydraulic Fracturing.** Hydraulic fracturing involves the injection of a fracturing fluid at a pressure (as typically determined by a DFIT) needed to induce fractures within the producing formation. The process generally proceeds in three sequential steps: (1) injection of a fracturing fluid without proppant to create fractures which extend out from the well; (2) injection of a slurry of fracturing fluid and proppant; and (3) injection of breakers, chemicals added to reduce the viscosity of the fracturing fluid. Upon release of pressure, the fracturing fluid is allowed to flow back (the flowback fluid) to the surface platform. Key fluid additives include polymer gels which increase the viscosity of the fluid and allow it to more easily carry proppant into the fractures, crosslinker compounds that help further increase the fluid viscosity, and breaker chemicals which break down the crosslinked polymers and allow them to return more readily to the surface after fracturing is completed. Other important additives may include pH buffers, clay control additives, microbial biocides, and surfactants to aid in fluid recovery. In offshore applications, the base fracturing fluid is filtered seawater.

[1] A proppant is a solid material, typically sand, treated sand, or man-made ceramic materials, designed to keep an induced fracture open during or following a fracture treatment.

- **Acid Fracturing.** Acid fracturing is similar to hydraulic fracturing except that instead of using a proppant to keep fractures open, an acid solution is used to etch channels in the rock walls of the fractures, thereby creating pathways for oil and gas to flow to the well. As with a hydraulic fracturing WST, a pad fluid is first injected to induce fractures in the formation. Next, the acid fracturing fluid is injected at pressures above the formation fracture pressure and allowed to etch the fracture walls. The acid fracturing fluid is typically gelled, cross-linked, or emulsified to maintain full contact with the fracture walls. Fifteen percent hydrochloric acid (15% HCl) solutions are typically used in carbonate formations such as limestone and dolomite, while hydrofluoric acid (HF) solutions and HCl/HF mixtures are used in sandstone and Monterey shale formations and in other more heterogeneous geologic formations, typically at levels of 12% and 3%, respectively. The fracturing fluid typically also includes a variety of additives at a combined concentration on the order of 1% or less, such as inhibitors to prevent corrosion of the steel well casing, and sequestering agents to prevent formation of gels or iron precipitation which may clog the pores.

- **Matrix Acidizing.** In matrix acidizing, a non-fracturing treatment, an acid solution, is injected into a formation where it penetrates pores in the rock to dissolve sediments and muds. By dissolving these materials, existing channels or pathways are opened and new ones are created, allowing formation fluids (oil, gas, and water) to move more freely to the well. Matrix acidizing also removes formation damage around a wellbore, which also aids oil flow into the well. The acid solution is injected at pressures below the formation fracture pressure and is thus a non-fracturing treatment. Three distinct fluids are commonly used sequentially: (1) an HCl acid preflush fluid; (2) a main acidizing fluid generated from mixing HCL and ammonium bifluoride to produce an HCl/HF mud acid at typically 12% and 3%, respectively (some operations use mud acid, for example sandstone and Monterrey shale while some operations primarily use 15% HCl); and (3) an ammonium chloride overflush fluid. The acidizing fluid also includes a variety of additives at a combined concentration of on the order of 1% or less, similar to those used in acid fracturing.

This EA analyzes the following alternatives that meet the purpose and need of the proposed action:

- **Alternative 1: Proposed Action—Allow Use of WSTs.** Under this alternative, BSEE technical staff and subject matter experts will continue to review applications for permit to drill (APDs) and applications for permit to modify (APMs), and, if deemed compliant with performance standards identified in BSEE regulations at Title 30, *Code of Federal Regulations*, Part 250, subpart D (30 CFR Part 250, subpart D), will approve the use of fracturing and non-fracturing WSTs at the 22 production platforms located on the 43 active leases on the Southern California OCS.

- **Alternative 2: Allow Use of WSTs with Subsurface Seafloor Depth Stipulations.** Under this alternative, no use of fracturing WSTs would be approved at depths less than 2,000 ft (610 m) below the seafloor surface. This alternative is intended to reduce the likelihood that a fracturing WST would produce fractures that could intersect an existing fault, fracture, or well and potentially create a pathway to the seafloor surface and result in a hydrocarbon release to the ocean.

- **Alternative 3: Allow Use of WSTs but No Open Water Discharge of WST Waste Fluids.** Under this alternative, no WSTs would be approved that use open ocean disposal of any WST-related waste fluids (such as the flowback) or of produced water comingled with WST waste fluids. This alternative is intended to eliminate any potential effects of discharges of WST-related chemicals on the marine environment. Currently permitted open water discharge of produced water could continue when produced water does not contain WST-related chemicals. When WST-related chemicals are present, produced water would need to be disposed by alternative means such as through injection. Additional injection wells could be needed at one or more of the platforms where disposal currently occurs only via permitted open water discharge.

- **Alternative 4: No Action—Allow No Use of WSTs.** Under this alternative, none of the four WSTs identified for the proposed action would be approved for use in any current or future wells on the 23 platforms associated with active lease areas on the Southern California OCS. This alternative would eliminate all effects of the use of WSTs. Production at some wells may be expected to decline sooner than under the proposed action, as reservoir pressures continue to decline with primary production. Routine well maintenance activities (e.g., wellbore cleanup) and enhanced oil recovery techniques (e.g., water flooding) that fall outside of the SB-4 definitions of WSTs would continue (as they would under any of the other three alternatives). For example, well maintenance conducted with the well tree installed, which may not require specific BSEE approval, would continue, including (1) acid wash (a form of acid treatment), (2) solvent wash (a chemical method of cutting paraffin), (3) casing scrape/surge (a method of scale or corrosion treatment and swabbing), and (4) pressure/jet wash (a method of bailing sand and a scale or corrosion treatment). In addition, well maintenance operations that require removal of the tree, which are not considered routine and need an approved APM, would also continue.

ES.4 AFFECTED ENVIRONMENT

The 43 lease areas where WSTs may be carried out represent the project area for the proposed action. Figure ES-1 shows the project area and the platforms in Federal and State waters. The geographic scope of the affected environment includes the project area and the

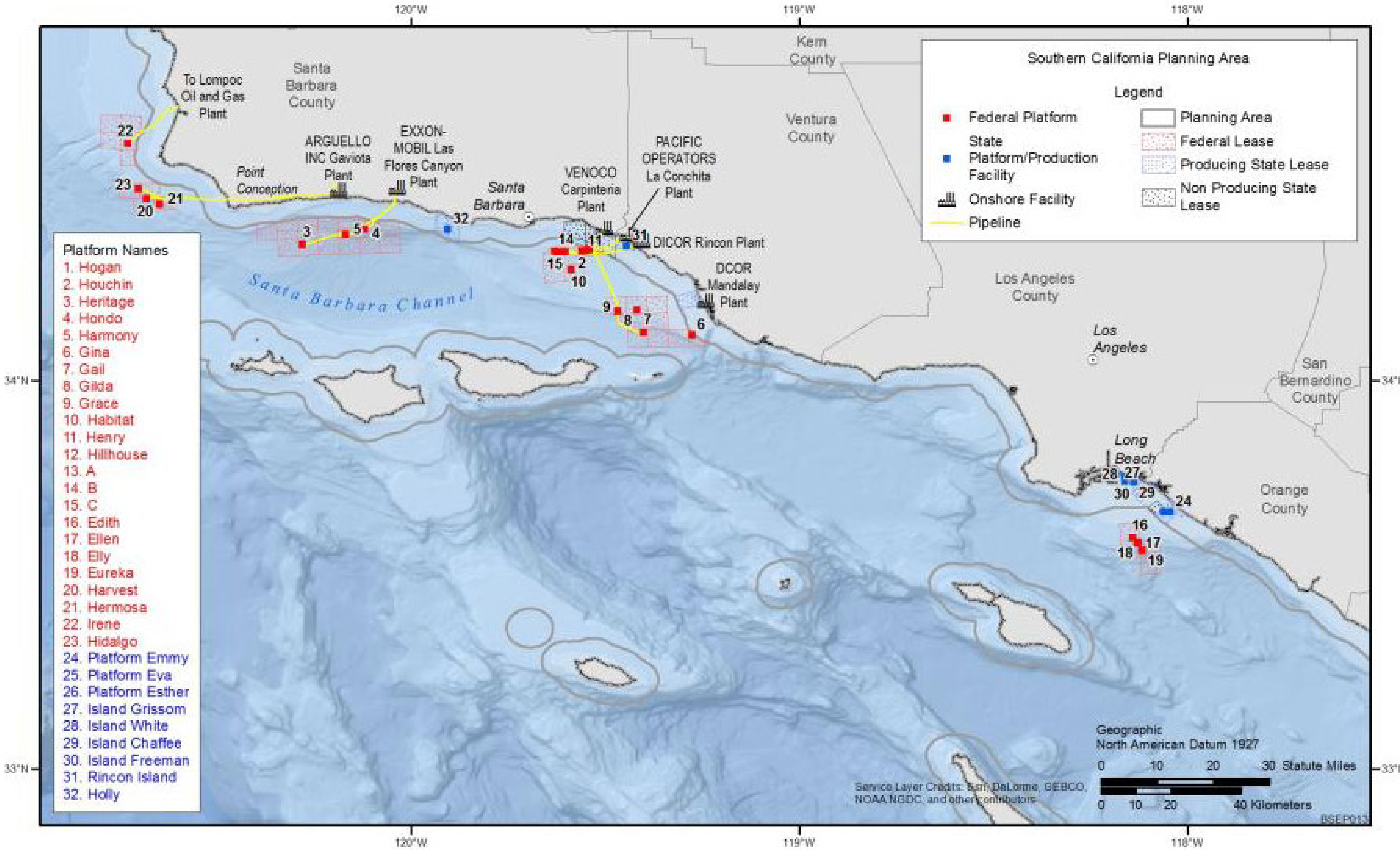

FIGURE ES-1 Locations of Current Lease Areas and Platforms Operating on the Southern California OCS Planning Area (Also shown are platforms and production facilities in offshore State waters adjacent to the Federal OCS.)

surrounding area, to the extent that potential effects from the proposed action could extend beyond the project area.

The following potential effects on resources of WST activities carried out in the project area were evaluated:

- *Air quality*: Potential impacts due to contributions to elevated photochemical ozone from ozone precursor emissions from diesel pumps and support vessels; contributions to visibility degradation from emissions of particulate matter; and contributions of greenhouse gas emissions associated with routine WST activities; temporary effects on air quality from releases of WST fluids and hydrocarbons under potential accidents; and from potential emissions during drilling of new injection wells which may be needed under Alternative 3.

- *Water quality*: Potential impacts of routine WST operations on water quality and marine life within the 100-m radius mixing zone defined under the U.S. Environmental Protection Agency (EPA) National Pollutant Discharge Elimination System (NPDES) general permit from WST waste fluids in permitted discharges to the ocean; compliance with the provisions of the permit would prevent effects outside the mixing zone; potential impacts on water quality from the release of WST fluids or hydrocarbons from potential accidents. Temporary and localized decreases in water quality that may occur as a result of bottom-disturbing activities that may occur under Alternative 3.

- *Geologic resources/seismicity*: Small potential that WSTs may stimulate seismic activity in seismically active areas such as the Santa Barbara Channel, and thus result in an increase in seismic hazard in the vicinity of the wells where fracturing WSTs are being implemented.

- *Benthic resources (including special status species)*: Potential lethal, sublethal, or displacement impacts on benthic communities following ocean disposal of WST waste fluids or the accidental release of WST fluids or hydrocarbons from potential accidents; and contamination of Endangered Species Act (ESA)-designated critical habitat with hydrocarbons and WST fluids following an accidental release. Benthic resources may also be affected by bottom-disturbing activities under Alternative 3.

- *Marine and coastal fish (including special status species) and essential fish habitat*: Potential lethal, sublethal, or displacement impacts on fish following ocean disposal of WST waste fluids or the release of WST fluids or hydrocarbons from potential accidents; contamination of Essential Fish Habitat (EFH) and ESA-designated critical habitat with hydrocarbons and WST fluids following an accidental release. Marine and coastal fish may also be affected by bottom-disturbing activities that may occur under Alternative 3.

- *Marine and coastal birds (including special status species)*: Potential lethal or sublethal effects following ocean disposal of WST waste fluids or the accidental release of WST fluids or hydrocarbons from potential accidents.

- *Marine mammals (including special status species)*: Potential lethal or sublethal effects following ocean disposal of WST waste fluids or release of WST fluids and hydrocarbons from potential accidents; vessel strikes. Marine mammals may also be affected by noise from bottom-disturbing activities that may occur under Alternative 3.

- *Sea turtles*: Potential lethal or sublethal effects following ocean disposal of WST waste fluids or release of WST fluids or hydrocarbons from potential accidents; and vessel strikes, noise, and other disturbances associated with WST operations. Sea turtles may also be affected by bottom-disturbing activities that may occur under Alternative 3.

- *Commercial and recreational fisheries*: Potential impacts due to preclusion from fishing areas due to interference with vessels transporting WST materials and equipment; localized closure of fisheries due to accidental release of WST fluids or hydrocarbons; and reduced abundance of fishing resources due to exposure to accidental release of WST fluids or hydrocarbons or to routine disposal of WST waste fluids.

- *Areas of Special Concern*: Potential impacts if water quality is affected; some biological resources potentially affected as identified above.

- *Recreation and Tourism*: Potential impacts if water quality is affected and use of recreational areas is affected.

- *Environmental Justice*: Reduced use of coastal and offshore areas by minority and low-income populations following accidental release of WST fluids and waste fluids.

- *Archaeological Resources*: The proposed action would not affect archaeological resources, except potential from bottom-disturbing activities that may occur under Alternative 3.

ES.5 ENVIRONMENTAL CONSEQUENCES

ES.5.1 WST Operations

Each of the four WSTs included in the proposed action have been used in Federal and State waters off of southern California. Of the more than 1,450 exploration and development wells that have been drilled in Federal waters on the southern California OCS between 1982 and

2014, there have been only 21 hydraulically fractured completions, and these were conducted on only 4 of the 23 platforms in Federal waters on the OCS. Three of these were in the Santa Barbara Channel, and the fourth was in the Santa Maria Basin. Only three matrix acidizing treatments, as defined as WSTs under SB-4, occurring in OCS waters during a similar time frame (between 1985 and 2011) have been identified in records, and these were conducted on only 2 of the 23 platforms.

The application of any of the WSTs included in the proposed action follows three basic steps: (1) the delivery of WST materials (i.e., WST chemical additives and proppant [typically sand]) to a platform; (2) the injection of WST fluids into the well undergoing treatment; and (3) the collection, handling, and disposal of WST-related waste fluids. Implementation of any of the WSTs included in the proposed action would largely use existing infrastructure, would require no construction of new infrastructure (e.g., no new pipelines, no new platforms), and would not result in bottom-disturbing activities (e.g., trenching), except potentially the drilling of new injection wells under Alternative 3. Some minor equipment changes may occur that would not entail any seafloor disturbance (e.g., replacement of existing platform injection pumps or fluid storage tanks with higher capacity equipment).

Materials for WSTs would be delivered to platforms via platform service vessels (PSVs) which routinely bring materials, supplies, and personnel to and from the platforms. Additional PSV trips may be needed to bring WST-related materials to a platform, which would represent a short-term, localized, and minor increase in PSV traffic. All WST-related materials would be transported in shipping containers designed and certified for marine and offshore transport. Bulk liquids could be transported in 350-gal or 500-gal stainless-steel totes, and non-liquid materials (e.g., proppant) could be transported in appropriate steel transport pods, all designed for marine transport and in compliance with all applicable shipping and safety requirements.

During a WST, chemical additives and proppant, if required, are mixed into a base injection fluid, filtered seawater, which is sourced at each platform. WST fluid components are mixed as they are injected. WSTs are conducted under the conditions, for example, of pressure and volume, specified in the APD or APM for a particular WST. Pumping time will vary by the type of WST being conducted and the number of stages needed for completion. Pumping time may be as little as 10 minutes for a DFIT, and up to 4 hours per stage for a hydraulic fracturing treatment.

WST operations produce waste fluids containing WST-related chemicals recovered during production, and air emissions associated with the operation of WST-related equipment (e.g., injection pumps, blending units) and with the transport of WST materials and supplies to and from platforms (e.g., PSV traffic). Following completion of a WST, waste fluids containing WST-related chemicals are recovered, typically comingled with formation water, referred to as produced water, and recovered oil. This comingled fluid is collected, and the oil phase is separated from the water phase for later refining and sale. A fraction of the injected WST chemical additives is typically recovered and becomes part of the produced water waste stream following separation. Chemical additives are largely consumed during treatment or retained in the formation. The water phase is treated and disposed of in the same manner as that used for produced water during routine (non-WST) oil and gas production, via NPDES-permitted open water discharge, or by reinjection.

ES.5.2 Potential Releases from WST-Related Accidents

The three categories of accidents considered and analyzed in this EA were accidents occurring during (1) the transport of WST chemicals and fluids to platforms; (2) WST fluid injection; and (3) the handling, transport, treatment, and disposal of WST-related waste fluids. Some accident scenarios may be applicable to each of the four WSTs included in the proposed action, while other scenarios are applicable to only some of the WSTs.

An accidental release of WST chemicals could occur with any of the four WST types during the delivery of required materials and their subsequent offloading to a platform. Required WST chemicals would be delivered to a platform via a PSV and transported in sealed steel containers designed for marine transport and in compliance with applicable packaging and shipping requirements. Release of the contents of such containers would require the loss of control of the container and a breach of container integrity. Such a release during PSV transport under the expected infrequent use of WSTs on the Pacific OCS is considered to be very unlikely for the foreseeable future. A release of small quantities of WST chemical additives from a container during crane transfer from a PSV to platform storage is considered unlikely, but reasonably foreseeable.

During WST fluid injection, the accidental release of WST-related chemicals could occur as a result of equipment malfunction on the platform during fluid blending and injection. Malfunctions of blending units, injection pumps, manifolds, and other platform equipment could release small quantities of WST chemicals and result in a surface spill of WST chemical additives. Any such malfunctions would tend to be quickly detected and WST activities halted, and any releases would be quickly addressed through implementation of existing spill containment and cleanup measures. Thus, although such accidental releases may occur, they would likely result in the release of only small quantities of WST chemicals that may or may not reach the open ocean. This accident scenario is considered to have a low probability of occurrence but is still reasonably foreseeable.

For the fracturing WSTs, accidental releases of WST chemicals and formation hydrocarbons may occur as a result of well casing failure during injection after repeated pressurization and depressurization events, thus providing a pathway for well fluids to pass along the outside of the well casing, migrate upward, and be released from the seafloor. Such an accident scenario, while possible, is considered to have a very low probability of occurrence and is not reasonably foreseeable.

An accidental release of WST chemicals may also occur during a fracturing WST if a new fracture contacts an existing pathway (e.g., an existing fault or other well) to the seafloor. Such an occurrence could result in the accidental release of WST chemicals, hydrocarbons, and produced water via a seafloor surface expression. Given BSEE requirements that all APDs and APMs include information on known fractures, faults, and wells in the vicinity of the proposed

WST, and requirements for continuous monitoring of injection pressures during a fracturing, the injection of fracturing fluids would be halted if a pathway to the seafloor was suspected, thus greatly reducing the potential of a seafloor surface expression to the ocean. This accident scenario, referred to as a surface expression, is considered to have a very low probability of occurrence and is not reasonably foreseeable.

Finally, an accidental release of any recovered WST-related chemicals in waste fluids may occur if a break occurs in a pipeline that is carrying such waste fluids as part of the produced water or the crude oil/produced water mixture (before separation) and these fluids are released to the ocean. Given the expected low frequency of WST use on the southern California OCS and required regular inspection of pipelines, such an accident has a very low probability of occurrence and is considered not reasonably foreseeable.

ES.5.3 Summary of Impacts on Resources

Evaluations of potential effects on resources characterize such effects with regard to how widespread any impacts might be (e.g., localized around platforms or affecting a much larger portion of the southern California OCS), the magnitude of any potential effect (e.g., small or large increase in air pollutants, individual biota or populations affected), and the duration of any potential effects (e.g., short-term [days or weeks] or long-term [months or longer]).

Alternatives 1 through 3 include all four WST types analyzed; thus the nature of any potential WST-related impacts will be relatively similar among these alternatives in most respects. Alternative 3, which would prohibit ocean discharge, has additional potential impacts from drilling new injection wells, while any potential effects from ocean discharge of WST-related chemicals would be eliminated. Alternative 2 includes a minimum depth requirement that may reduce, in comparison to Alternatives 1 and 3, the likelihood of an accidental surface expression occurring. Alternative 4, No Action, would eliminate all impacts of WSTs. Because impacts from routine operations and the risk of accidents are low for Alternative 1, there is only a marginal decrease in risk and potential impacts under Alternatives 2 through 4.

Table ES-1 presents a comparison of impacts on resources under the alternatives from routine operations. Table ES-2 presents a comparison of the likelihood of various accidents under the alternatives.

ES.6 CUMULATIVE IMPACTS

Given the consistently small estimated potential impacts of future WST activities on resources in the Pacific OCS off southern California, incremental contributions to impacts from the proposed action are not expected to result in any noticeable or material cumulative effects on resources potentially impacted by the proposed action when added to past, current, and foreseeable future impacts on these resources from other sources.

1 **TABLE ES-1 Comparison of Potential Effects among Alternatives from Routine Use of WSTs**

Resource	Alternative 1 Proposed Action – Allow Use of WSTs	Alternative 2 – Allow Use of WSTs with Depth Stipulation	Alternative 3 – Allow Use of WSTs with No Open Water Discharge of WST Fluids	Alternative 4 – No WST Use on Existing OCS Leases
Air quality	No noticeable WST-related impacts on regional air quality expected. Negligible emissions of greenhouse gases.	Same as Alternative 1.	Same as Alternative 1. Additional air emissions if new injection well drilling and pipeline trenching occur.	No WST-related impacts.
Water quality	No WST-related impacts expected; although slight localized reduction in water quality at surface water discharge location.	Same as Alternative 1.	Similar to Alternative 1, but no reductions in water quality from WST chemicals in discharges to surface water. Temporary and localized reduction in water quality if new injection well drilling and/or pipeline trenching occur.	No WST-related impacts.
Induced seismicity	Low potential for induced seismicity.	Same as Alternative 1.	Same as Alternative 1.	Same as Alternative 1.
Benthic resources	No WST-related impacts expected.	Same as Alternative 1.	Same as Alternative 1. Localized and temporary benthic habitat disturbance likely if new injection well and/or pipeline trenching occur.	No WST-related impacts.
Marine and coastal fish; sea turtles, marine and coastal birds, marine mammals	No WST-related impacts expected; potential for subtle toxic effects in some species from some WST chemicals occurring within the NPDES discharge mixing zone from discharges of WST waste fluids to surface water.	Same as Alternative 1.	Similar to Alternative 1 but with no potential for exposure to WST chemicals in discharges to surface water. Localized and temporary habitat disturbance and/or displacement of individuals likely if new injection well and/or pipeline trenching occur.	No WST-related impacts.
Commercial and recreational fisheries	No WST-related impacts expected.	Same as Alternative 1.	Same as Alternative 1. Localized and temporary habitat disturbance and/or displacement of individuals likely if new injection well and/or pipeline trenching occur.	No WST-related impacts.

TABLE ES-1 (Cont.)

Resource	Alternative 1 Proposed Action – Allow Use of WSTs	Alternative 2 – Allow Use of WSTs with Depth Stipulation	Alternative 3 – Allow Use of WSTs with No Open Water Discharge of WST Fluids	Alternative 4 – No WST Use on Existing OCS Leases
Areas of special concern, recreation and tourism, archaeological resources, environmental justice	No WST-related impacts expected.	Same as Alternative 1	Same as Alternative 1. Localized and temporary habitat disturbance and/or displacement of individuals likely if new injection well construction occurs.	No WST-related impacts.
Socioeconomics	No WST-related impacts or benefits expected.	Same as Alternative 1	Same as Alternative 1. Platform operators may incur additional costs if new injection wells or disposal pipelines are needed.	No WST-related impacts. Decommissioning costs may be incurred at some wells that become unproductive in the absence of WST use.

TABLE ES-2 Comparison of Likelihood of Occurrence of WST-Related Accidents among Alternatives

	Likelihood			
Accident	Alternative 1 Proposed Action – Allow Use of WSTs	Alternative 2 – Allow Use of WSTs with Depth Stipulation	Alternative 3 – Allow Use of WSTs with No Open Water Discharge of WST Fluids	Alternative 4 – No WST Use on Existing OCS Leases
WST chemical release during transport following loss of transport container integrity	Applicable to all four WST types. Very low probability and not reasonably foreseeable.	Same as Alternative 1.	Same as Alternative 1.	Will not occur.
WST chemical release during crane transfer	Applicable to all four WST types. Low probability and reasonably foreseeable.	Same as Alternative 1.	Same as Alternative 1	Will not occur.
WST chemical release during injection from platform equipment malfunction	Applicable to all four WST types. Low probability and reasonably foreseeable.	Same as Alternative 1.	Same as Alternative 1.	Will not occur.
Seafloor expression of WST chemicals due to well casing failure	Applicable only to fracturing WSTs. Very low probability and not reasonably foreseeable.	Same as Alternative 1.	Same as Alternative 1.	Will not occur.
Seafloor expression of WST chemicals due to fracture intercept with existing surface pathway	Applicable only to fracturing WSTs. Very low probability and not reasonably foreseeable.	Reduced probability compared to Alternative 1.	Same as Alternative 1.	Will not occur.
Release of WST chemicals due to rupture of pipeline conveying produced water containing WST chemicals	Applicable to all WSTs. Very low probability and not reasonably foreseeable.	Same as Alternative 1.	Same as Alternative 1.	Will not occur.

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1 INTRODUCTION

1.1 BACKGROUND

The Submerged Lands Act of 1953, as amended (43 U.S.C. §§ 1301 et seq. [67 Stat. 29]) established Federal jurisdiction over submerged lands seaward of State boundaries. The Outer Continental Shelf Lands Act (OCSLA) of 1953, as amended (43 U.S.C. §§1331 et seq.), directs the Secretary of the Interior to establish policies and procedures that expedite exploration and development of the Outer Continental Shelf (OCS) for the production of resources (e.g., oil and natural gas) in a safe and environmentally sound manner. The Secretary of the Interior oversees the OCS oil and gas program, and under the OCSLA is required to balance orderly resource development with protection of the human, marine, and coastal environments while simultaneously ensuring that the public receives an equitable return for these resources. Section 5 of OCSLA grants the Secretary the right to provide for the "prevention of waste and conservation of natural resources" of the OCS.

There are currently 43 active leases in Federal waters on the Southern California OCS (Figure 1-1). Among these leases in Federal waters, 14 oil and gas fields[1] are currently being produced by 23 platforms (22 producing and one processing; see Section 2). The first of these platforms was installed in 1967, and the last two platforms were both installed in 1989. By comparison, there are nine active offshore drilling and production locations in State waters off southern California; these include four platforms and five artificial islands (Figure 1-1).

The Secretary's responsibilities under the OCSLA have been delegated to the Bureau of Ocean Energy Management (BOEM) and the Bureau of Safety and Environmental Enforcement (BSEE), and together they are responsible for ensuring that resource exploration, development, and production activities carried out on the OCS (including on the Southern California OCS Planning Area) are done in compliance with the requirements of OCSLA. BOEM is responsible for managing environmentally and economically responsible development of the nation's offshore resources. BOEM functions include offshore leasing, resource evaluation, review and administration of oil and gas exploration and development plans, renewable energy development, National Environmental Policy Act (NEPA) analysis, and environmental studies. BSEE is responsible for safety and environmental oversight of offshore oil and gas operations including permitting and inspections of offshore oil and gas operations. BSEE functions include the development and enforcement of safety and environmental regulations, permitting offshore exploration, development and production activities, inspections, offshore regulatory programs, and oil spill preparedness plan review.

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[1] An oil or gas field is a region where multiple oil or gas wells are extracting hydrocarbons from subsurface formations. An oil and gas reservoir is a subsurface pool of hydrocarbons (i.e., crude oil and natural gas) contained in porous or fractured rock formations and trapped by overlying rock formations with lower permeability.

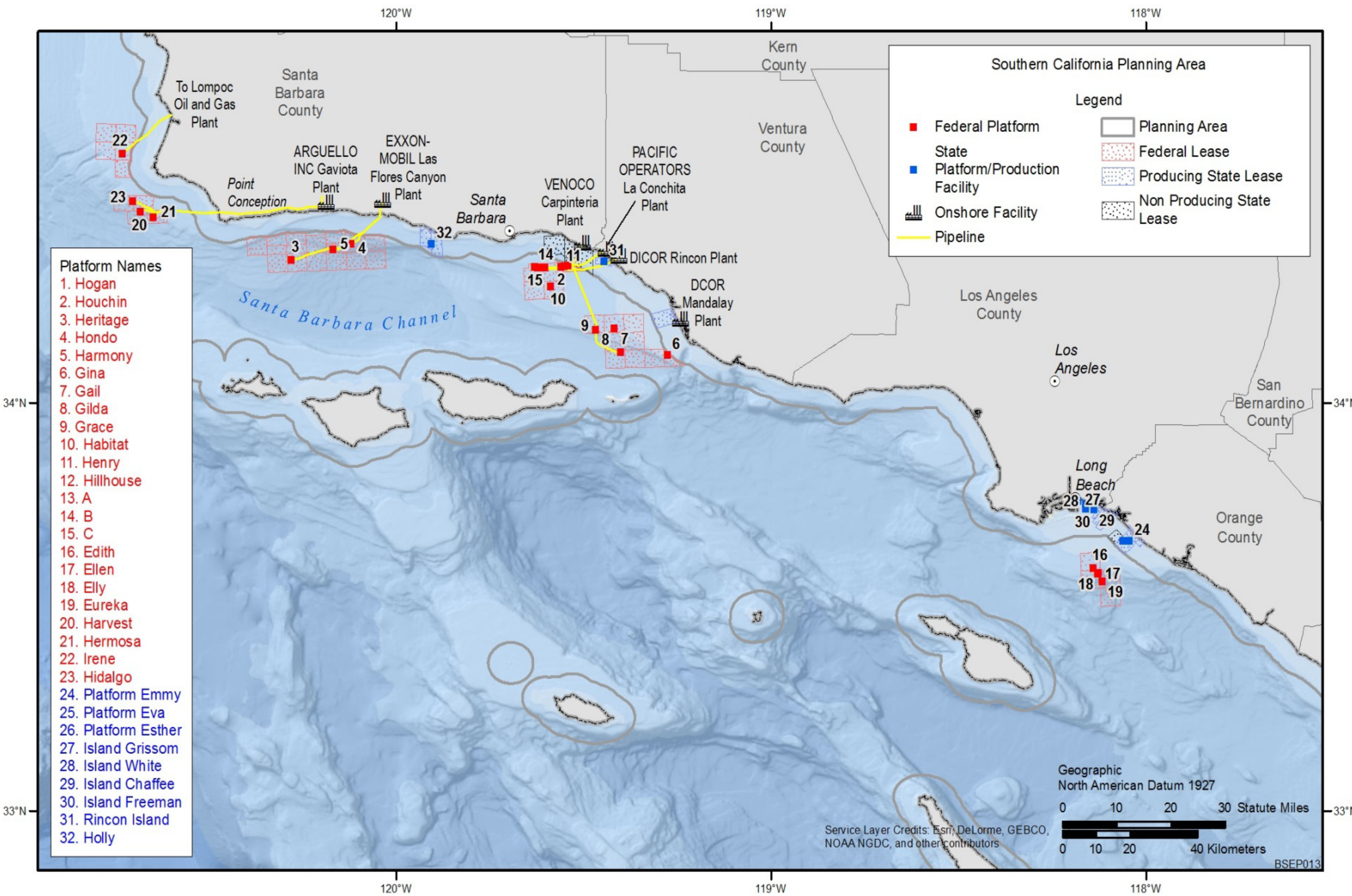

FIGURE 1-1 Locations of Current Lease Areas and Platforms Operating on the Southern California OCS Planning Area (Also shown are platforms and production facilities in offshore State waters adjacent to the Federal OCS. Platforms in Federal waters are shown and listed in red; those in State waters are indicated in blue.)

BSEE and BOEM propose to allow the use of selected well stimulation treatments (WSTs) on the current active leases and operating platforms on the Southern California OCS, which may allow lessees to recover hydrocarbon resources (i.e., oil) that would otherwise not be recovered from the reservoirs in the 43 lease areas that have been and continue to be accessed by existing wells and any new wells in the foreseeable future.

In accordance with the National Environmental Policy Act (NEPA) of 1969, BSEE and BOEM prepared this environmental assessment (EA) to evaluate the potential environmental impacts of the proposed approval of the use of WSTs on the 23 platforms currently in operation on the Southern California OCS Planning Area. The BSEE and BOEM are joint lead agencies in the preparation of this EA.

This EA presents the purpose and need for the proposed action, describes the proposed action and reasonable alternatives to the proposed action, and identifies and evaluates the reasonably foreseeable environmental impacts of the proposed action and alternatives in order to determine whether there is potential for significant environmental impact and therefore whether an environmental impact statement (EIS) should be prepared. This EA was prepared in accordance with the Council of Environmental Quality (CEQ) regulations (40 CFR 1500–1508) implementing NEPA.

1.2 PURPOSE AND NEED FOR THE PROPOSED ACTION

The purpose of the proposed action is to allow the use of certain WSTs (e.g., hydraulic fracturing) in support of oil production at platforms on the Pacific OCS. The use of WSTs may improve resource extraction from some existing wells, and in some future new wells, on the Pacific OCS. Allowing the use of WSTs is consistent with BSEE and BOEM responsibilities under OCSLA for effectively managing resources on the Federal OCS, and is in accordance with DOI’s obligations and responsibilities under OCSLA.

Oil serves as the feedstock for a variety of liquid hydrocarbon products, among them transportation fuels and various petrochemicals. Natural gas is generally considered an environmentally preferable alternative to oil to generate electricity or for residential and industrial heating, and is an important feedstock for manufacturing fertilizers, pharmaceuticals, plastics, and packaging. In 2014, the United States consumed approximately 19.0 million barrels (bbl) of oil per day, of which about 74% percent was produced domestically and 26% originated from foreign sources (EIA 2015). In 2014, the United States also consumed about 26.8 trillion cubic feet (Tcf) of natural gas, about 90% of which was produced domestically (EIA 2015).

During initial recovery (primary recovery) of an oil and gas reservoir, production is a function of the naturally occurring pressure of the reservoir, as well as the porosity of the formation. During primary recovery, existing reservoir pressure drives the oil through naturally occurring pores, channels, and fractures in the formation and to the production well. As reservoir pressure decreases over time with production, the movement of oil to the production well also declines. Typically, about 30–35% of the oil present in the reservoir at the start of production is recovered during primary recovery (Hyne 2012). Advances in WSTs and the availability of enhanced oil recovery (EOR) techniques[2] have allowed for continued production from onshore and offshore reservoirs where primary recovery has begun to decline as a result of declining reservoir pressures. The reservoirs associated with the 43 active leases on the Southern California OCS have been in production from 26 to 48 years, and reservoir pressures have been gradually declining with this production. The use of WSTs may support the continued recovery of oil as primary recovery declines with the 43 active lease areas.

The Secretary of the Interior oversees the OCS oil and gas program under OCSLA, and BOEM and BSEE are the agencies charged with this oversight and regulated management of the permitted or otherwise authorized oil and gas activities. BSEE is responsible for enforcing safety and environmental regulations regarding the exploration, development, and production of resources (e.g., oil and natural gas) on the OCS. BSEE carries out this responsibility by conducting an offshore regulatory program that develops standards and regulations for enhancing safety and environmental protection during the exploration, development, and production of offshore oil and natural gas. BOEM is responsible for managing the development of offshore resources on the OCS, with functions that include leasing, plan administration, environmental studies, resource evaluation, and economic analysis. BOEM develops the Five Year OCS Oil and Natural Gas Leasing Program; oversees assessments of oil, natural gas, and other mineral resource potentials of the OCS; inventories hydrocarbon reserves; develops production projections; and conducts economic evaluations to ensure fair market value is received by U.S. taxpayers for OCS leases. Together, these agencies are responsible for effectively and safely managing resources on the OCS in accordance with the Secretary's obligations and responsibilities under OCSLA. These responsibilities include the conservation of OCS resources, as well as balancing orderly resource development with protection of the human, marine, and coastal environments while ensuring that royalties are received from existing OCS leases, as the result of oil and gas production, by the U.S. Treasury (43 U.S.C. 1332(3)).

Following the approval of a development and production plan (DPP) for proposed drilling at a platform, the platform operator is required to submit an Application for Permit to Drill (APD) to BSEE before commencing drilling activities. BSEE's permitting authority for the proposed drilling activities is pursuant to the OCSLA Subpart D regulations. In response to the proposed action in the operator's APD, BSEE has regulatory responsibility to approve, approve with modifications or mitigation, or deny the permit. BSEE regulations provide criteria that the agency will apply in reaching a decision and in providing for any applicable mitigation or conditions of approval (see 30 CFR 250). Additional permitting may also be submitted subsequent to the APD, if relatively minor modifications are needed. If an operator with an approved APD wishes to revise some aspects of the APD, they must submit an Application for Permit to Modify (APM)[3] to BSEE for review and approval.

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[2] Enhanced recovery techniques are used to further increase the amount of crude oil that can be extracted from a reservoir. These techniques fall into three major categories—thermal recovery, gas injection, and chemical injection.

[3] Per 30 CFR 250.465, an APM (form BSEE-0124) must be submitted when an operator intends to (1) revise the drilling plan, change major drilling equipment, or plugback; (2) determine a well's final surface location, water depth, and the rotary kelly bushing elevation; or (3) move a drilling unit from a wellbore before completing a well. Plugback refers to the placement of cement or other material in a well to seal off a completion interval, to

When the BSEE Pacific OCS Regional Office receives an APD or APM containing WST operations, the APD/APM is reviewed by California District Office Well Operations Section engineers. The required APM/APM District Production Engineering, Blowout Preventer (BOP) Control System Drawing, and Hydraulic Fracturing Engineering Data reviews are conducted and documented in the eWell Permitting and Reporting System (eWell).[4] Concurrently, BSEE staff in the Regional Office of Production and Development (OPD) review the APD/APM for conservation of oil and gas resources as well as for potential geohazards. If the APD or APM is for a hydraulic fracture operation, OPD will also look at the proposed fracture in relation to active faults and the location of other wellbores, staying at least 1000 ft away from either. The OPD then documents the geologic review in eWell. Environmental Compliance personnel from the California District Office review the existing NEPA analysis, tiering from the relevant production plan and drilling permit, to determine if it is adequate for the APD or APM, or if additional NEPA analyses or findings are needed. Once completed, the review and resulting information are also documented in eWell. Upon completion of all of these reviews, provided the information is compliant with all applicable standards and regulations, the California District Office approves the permit in eWell.

Evaluation in this EA of relevant environmental and other data will aid in the identification of the potential nature and magnitude of environmental impacts that may be associated with the use of WSTs on the 43 active lease areas on the Southern California OCS. Information gathered here will also help ensure that DOI achieves its mission of efficient production and conservation of OCS energy resources and the receipt of fair market value from the leasing of public lands. The development of this EA will facilitate DOI meeting other environmental requirements related to future authorizations, such as Endangered Species Act, Marine Mammal Protection Act, and Coastal Zone Management Act requirements.

1.3 REFERENCES

EIA (U.S. Energy Information Administration), 2015, *Frequently Asked Questions: How Much Oil is Consumed in the United States*, U.S. Department of Energy, Washington, DC. Available at http://www.eia.gov/tools/faqs/faq.cfm?id=33&t=6.

Hyne, N.J., 2012, *Nontechnical Guide to Petroleum Geology, Exploration, Drilling, and Production*, 3rd Edition, Pen Well Corporation, Tulsa, OK.

exclude bottom water, or to perform another operation such as side-tracking or producing from another depth. The term also refers to the setting of a mechanical plug in the casing.

4 BSEE's eWell is a comprehensive Internet permitting and reporting system for collecting information concerning well operations for each wellbore and well completion. It includes permits that are needed before drilling and other well operations can take place, as well as reports containing data and information provided at certain times during and after operations on a wellbore. The data collected are in the interest of resource evaluation, waste prevention, conservation of natural resources, and protection of correlative rights, safety, and the environment. Once the data are collected, the eWell System has a built-in review process that allows BSEE to approve or disapprove the submitted information. The eWell database is publically available at http://www.data.bsee.gov/homepg/data_center/plans/apdform/master.asp.

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2 ALTERNATIVES, INCLUDING THE PROPOSED ACTION

2.1 INTRODUCTION

The proposed action and alternatives evaluated in this EA include well stimulation treatments (WSTs) that have been, or may be, employed at any of the production platforms operating on the 43 active leases on the Southern California OCS (Figure 2-1). For the purposes of this EA, the 43 lease areas where WST activities may be carried out represent the project area for the proposed action. The WSTs evaluated in this EA include fracturing and non-fracturing treatments that may be used for enhancing production from existing and new wells where formation permeability and decreasing reservoir pressure are limiting oil recovery.[1] These WSTs are commonly used at onshore wells in California and throughout the United States, and on occasion in wells in offshore Federal and State of California waters (Long et al. 2015a). An overview of the historic use of WSTs on the Southern California OCS and adjacent State waters is presented in Section 4.1.

A number of definitions of WST, acid WST, and hydraulic fracturing occur in the open scientific and industry literature, although many are largely similar in nature. This EA adopts the definitions that are found in Sections 3152, 3157, and 3158 of State of California Senate Bill No. 4 (SB-4) Oil and Gas: Well Stimulation. Adoption of the SB-4 definitions was done for a number of reasons. First, SB-4 applies these definitions to hydraulic fracturing and other WST activities that are occurring in State of California waters and accessing the same formations as those being accessed by platforms on the 43 active Federal lease areas on the Southern California OCS. The SB-4 definitions also apply to WST activities that are being widely used on land in California. Second, adopting the SB-4 definitions will allow for more straightforward and clear comparisons of WST applications between Federal and State offshore operations and promoting the cumulative effects analysis. The following SB-4 definitions were adopted for use in this EA:

- *Well Stimulation Treatment*—means any treatment of a well designed to enhance oil and gas production or recovery by increasing the permeability of the formation. Well stimulation treatments include, but are not limited to, hydraulic fracturing treatments and acid well stimulations (SB-4 Section 3157a). As defined in SB-4 Section 3157b, routine well cleanout work, routine well maintenance, routine removal of formation damage due to drilling, bottom hole pressure surveys, and routine activities that do not affect the integrity of the well or the formation are not considered as WSTs.

- *Hydraulic Fracturing*—means a WST that, in whole or in part, includes the pressurized injection of hydraulic fracturing fluid or fluids into an underground geologic formation in order to fracture or with the intent to

1 Permeability refers to the ability of a formation's ability to transmit fluid; the higher its permeability, the more easily a fluid will flow through the formation. Formations such as sandstones are described as permeable and tend to have many large, well-connected pores and pathways. Impermeable formations such as shales and siltstones tend to be finer grained or of mixed grain size, with smaller, fewer, or less-interconnected pores and pathways.

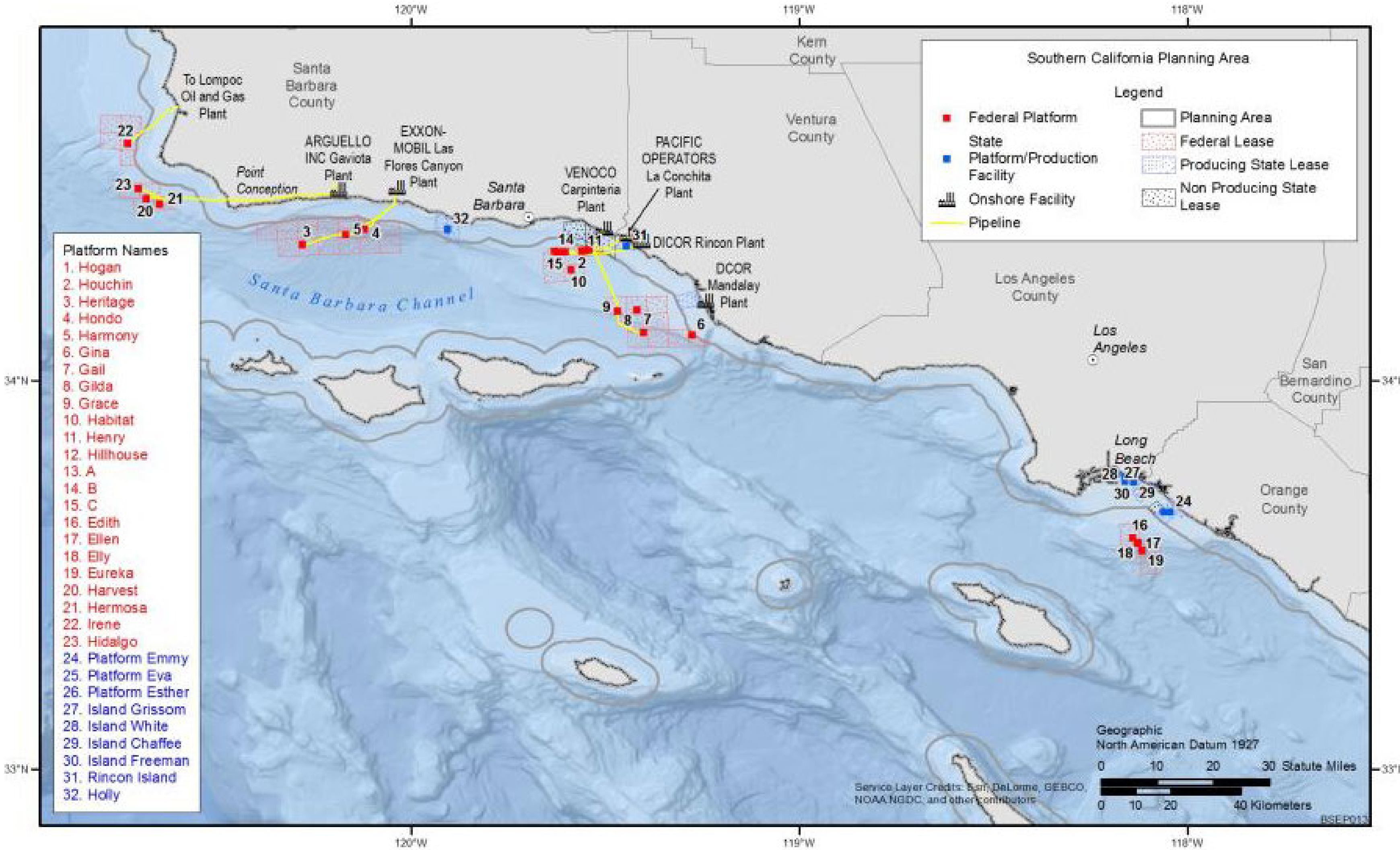

FIGURE 2-1 Locations of Current Lease Areas and Platforms (shown in red) Operating on the Southern California OCS Planning Area (Also shown [in blue] are platforms and production facilities in offshore State waters adjacent to the Federal OCS.)

> fracture the formation, thereby causing or enhancing […] the production of oil or gas from a well (SB-4 Section 3152).
>
> *Acid Well Stimulation Treatment*—means a WST that uses, in whole or in part, the application of one or more acids to the well or underground geologic formation (SB-4 Section 3158). The acid well stimulation treatment may be at any applied pressure and may be used in combination with hydraulic fracturing treatments or other well stimulation treatments. Acid well stimulation treatments include acid matrix stimulation treatments and acid fracturing treatments. Acid matrix stimulation treatments are well stimulation treatments conducted at pressures lower than the applied pressure necessary to fracture the underground geologic formation (and thus are not fracturing WSTs).

This EA refers to all treatments included in the proposed action and alternatives collectively as WSTs. Accordingly, a "fracturing WST" hereafter refers to a WST in which WST fluids are injected at pressures required to fracture the formation (i.e., greater than the formation fracture pressure), while any WST in which the WST fluid is injected at less than the pressure required to hydraulically fracture the formation is referred to as a "non-fracturing WST."

2.2 PROPOSED ACTION AND OTHER ALTERNATIVES CONSIDERED

2.2.1 Alternative 1: Proposed Action—Allow Use of WSTs

Under this alternative, BSEE technical staff and subject matter experts will continue to review APDs and APMs and, if deemed compliant with performance standards identified in BSEE regulations at 30 CFR 250 subpart D, approve the use of fracturing and non-fracturing WSTs at the 22 production platforms located on the 43 active leases on the Southern California OCS (Figure 2-1). Alternative 1 includes three fracturing WSTs (diagnostic fracture injection tests, hydraulic fracturing, and acid fracturing) and a single non-fracturing WST (matrix acidizing). These four WSTs are described in the following sections.

Both the fracturing and the non-fracturing WSTs are used to increase the flow of hydrocarbons from the reservoir to the producing well. The fracturing WSTs do so by creating fractures in the oil-bearing formation along which hydrocarbons may flow to the well, while the non-fracturing WSTs dissolve materials in existing pathways or create new pathways for hydrocarbon flow to the well.

2.2.1.1 Fracturing WSTs Included in the Proposed Action

The three fracturing WSTs all have one thing in common; they are performed with injection pressures that exceed the formation fracture pressure. This results in the creation of fractures within the formation which increase conductivity of fluid (e.g., oil) from the reservoir to the wellbore. Three types of hydraulic fracture treatments are considered in this EA: the diagnostic fracture injection test, the hydraulic fracture, and the acid fracture.

Diagnostic Fracture Injection Test. The Diagnostic Fracture Injection Test (DFIT) is a widely used procedure which goes by many names in the industry, such as Data Frac, Mini-Frac, Mini Fall-off, and DFIT. A DFIT is used to estimate key reservoir properties and parameters that are needed to optimize the main fracture job, such as fracture closure pressure, fracture gradient, fluid leakoff coefficient, fluid efficiency, formation permeability, and reservoir pressure (SPE 2013; PetraCat Energy Services 2015). It is a short duration procedure that involves the injection of a small volume of fluid (typically less than 4,200 gal [100 barrels]) at pressures high enough to initiate a fracture. Once a fracture is formed, the well is closed and pressure is measured as it dissipates over time, typically within a day or two. Key parameters are estimated based upon the volume of fluid injected and the pressure profile within the well during pressure dissipation (Halliburton 2015). The fluid used in a DFIT is typically the fluid that would be used in the main fracture treatment but with no proppant[2] added, thus allowing the fracture to close naturally as pressure is released.

Hydraulic Fracturing. Reservoirs in unconsolidated sandstone formations produce sand along with the oil, and this sand can flow into the well and damage production equipment, reduce oil production, and present separation (sand from the oil) and waste disposal challenges at the surface. In a hydraulic fracturing WST, fracturing fluid is injected at a pressure (as typically determined by a DFIT) needed to induce fractures within the formation. The process generally proceeds in three sequential phases. Initially, a fracturing fluid without proppant (the “pad fluid”) is pumped into the formation to create fractures which extend out from the well. Next, the pad fluid is followed by a slurry of fracturing fluid and proppant. As this slurry reaches the end of the fractures, the proppant settles out, propping open the tips of the fractures (this is referred to as tip screen out). After tip screen out is achieved, slurry injection continues filling the fractures with proppant. Once the fractures are packed with proppant, breakers[3] are added to reduce the viscosity of the fracturing fluid (which allows the proppant to remain in place). Lastly, the pressure is released, and the fracturing fluid is allowed to flow (the flowback fluid) to the well and then up to the platform. On platforms on the Southern California OCS, the flowback fluid is typically collected comingled with production water from the well undergoing the WST and also with produced water from other wells on the platform. These combined fluids are then treated and disposed of accordingly (e.g., U.S. Environmental Protection Agency [EPA] National Pollutant Discharge Elimination System [NPDES]-permitted open water discharge, or reinjection).

Different hydraulic fracturing processes use a variety of fracturing fluid types depending upon the target formation properties, including water-based, oil-based, and acid-based fluids

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2 A proppant is a solid material, typically sand, treated sand, or man-made ceramic materials, designed to keep an induced fracture open during or following a fracture treatment.

3 A breaker is a chemical that reduces the viscosity of the fracturing fluids by breaking long-chain molecules present in the fluid into shorter segments.

(Hodge 2011). Key fluid additives include polymer gels that increase the viscosity of the fluid and allow it to more easily carry proppant into the fractures; crosslinker compounds that help further increase the fluid viscosity and thus better carry the proppant into the fracture; and breaker chemicals reduce the viscosity of the fluid and allow it to return more readily to the surface while leaving the proppant behind after the hydraulic fracturing WST is completed. Other important additives may include pH buffers, clay control additives, microbial biocides, and surfactants to aid in fluid recovery. In marine environments, the base fracturing fluid is filtered seawater.

Acid Fracturing. Acid fracturing is similar to a frac-pac except that instead of using a proppant to keep fractures open, it uses an acid solution to etch channels in the rock walls of the fractures, thereby creating pathways for oil and gas to more easily reach the well (API 2014). Because the pathways are etched, no proppant is required in the fracturing fluid (Long et al. 2015a).

As with a hydraulic fracturing WST, a pad fluid is first injected to induce fractures in the formation. Next, the acid fracturing fluid is injected at pressures above the formation fracture pressure and allowed to etch the fracture walls. The acid fracturing fluid is typically gelled, cross-linked, or emulsified to maintain full contact with the fracture walls. Hydrochloric acid (HCl) solutions are typically used in carbonate formations such as limestone and dolomite, while hydrofluoric acid (HF) solutions and HCl/HF mixtures are used in sandstone and Monterey shale formations. Mixtures of HCl and HF are also used in more heterogeneous geologic formations. Acid concentrations in the fluids vary; 15% HCl is commonly used in acid fracturing. In addition to the acid, the fracture fluid may include a variety of additives, such as inhibitors to prevent corrosion of the steel well casing, and sequestering agents to prevent formation of gels or iron precipitation which may clog the pores. The volume of acid fracturing fluid is generally determined by the length of the fracture being treated; typical acid volumes range from 10 to 500 gallons per foot (API 2014).

2.2.1.2 Non-Fracturing WSTs Included in the Proposed Action

The proposed action includes one non-fracturing treatment, the use of which is intended to increase formation permeability so that hydrocarbons can flow more readily, or to recover additional oil from a reservoir after initial production begins to decline as a result of decreasing reservoir pressure. The non-fracturing treatment included in the proposed action is matrix acidizing, which is specifically called out in SB-4 as an acid WST.

In matrix acidizing (also known as an acid squeeze), an acid solution is injected into a formation (at pressures below the formation fracture pressure) where it penetrates pores in the rock to dissolve sediments and muds (Ghali et al. 2007). By dissolving these materials, existing channels or pathways are opened and new ones are created, allowing formation fluids (oil, gas, and water) to move more freely to the well. Matrix acidizing also removes formation damage around a wellbore, which also aids oil flow into the well.

Matrix acidizing differs from acid fracturing (see Section 2.2.1.1) in that in the former the acid solution is injected at pressures below the formation fracture pressure and no new fractures would be created, while in the latter it is injected at pressures above the formation fracturing pressure in order to induce new fracture formation. As with acid fracturing, matrix acidizing in carbonate reservoirs uses HCl solutions, while alternating HF and HCl solutions are used in sandstone and Monterrey shale formations on the Southern California OCS (Long et al. 2015a). Other acids that have been used in matrix acidizing include acetic, formic, sulfamic, chloroacetic, phosphoric, and erythorbic acids (Portier et al. 2007; Ghalambar and Economides 2002). Matrix acidizing has had a relatively low level of use in onshore and offshore Monterey Formation fields in California (Jordon and Heberger 2014).

2.2.2 Alternative 2: Allow Use of WSTs with Subsurface Seafloor Depth Stipulations

Under this alternative, no fracturing WSTs would be allowed at depths less than 2,000 ft (610 m) below the seafloor surface. Fracturing WSTs produce bilateral fractures from the well, and well completions using fracturing WSTs are designed with an expected fracture half-wing length.[4] If a fracture produced during a WST were to intersect an existing fault, fracture, or well, there is a potential for the creation of a pathway to the seafloor surface and a subsequent hydrocarbon release to the ocean. Under Alternative 2, BSEE technical staff and subject matter experts would continue to review APDs and APMs involving the use of any of the WSTs included in the proposed action and, if determined to be compliant with performance standards identified in BSEE regulations at 30 CFR 250 subpart D, these activities would be approved. However, applications for fracturing WST use at depths of less than 2,000 ft below the seafloor would not be approved.

Because fracture wing lengths typically are in the range of tens to hundreds of feet in length (Fisher and Warpinski 2012 as cited in Long et al. 2015a), the 2,000-ft depth limit with Alternative 2 is intended to greatly reduce the already low likelihood of a fracture produced by a WST resulting in a surface expression of hydrocarbons at the seafloor. Injection pressure is continuously monitored during offshore fracturing operations on the Southern California OCS (Sinkula 2015). Following fracture initiation, a lack of pressure buildup or a detectable pressure loss during fracture propagation may indicate an unintended fluid leak off, suggesting that the fracture has intercepted an existing fault, fracture, or well. In such a case, the injection of fracturing fluids would cease and formation pressure would be allowed to return to pre-fracturing levels. The return to pre-fracturing formation pressure, together with the pressure from the overlying 2,000 ft of rock and the overlying hydrostatic pressure, would preclude the movement of hydrocarbons from the new fracture to the seafloor, and thus greatly reduce the potential of a surface expression of hydrocarbons at the seafloor to the ocean.

4 A fracture half-wing length is the length of one arm of a bilateral fracture.

2.2.3 Alternative 3: Allow Use of WSTs but No Open Water Discharge of WST Waste Fluids

Concerns have been raised by the public regarding the effects of open ocean disposal of WST waste fluids. Currently, for most platforms on the Southern California OCS produced water generated at a platform during hydrocarbon production is collected, often comingled with produced water from other wells and platforms, and transported via pipeline to shore for treatment. Following treatment, the produced water is either disposed of onshore by subsurface injection at permitted waste disposal wells, or returned via pipeline to the platforms for disposal either by injection to a reservoir or by open water discharge under NPDES General Permit CAG 280000 (administered by the EPA's NPDES permit program). At some platforms, produced water treatment occurs at the platform rather than at an onshore facility. Open ocean discharge from platforms is not permitted in State waters (Long et al. 2015b).

Under Alternative 3, BSEE technical staff and subject matter experts would continue to review the use of WSTs included in the proposed action and, if determined to be compliant with performance standards identified in BSEE regulations at 30 CFR 250 subpart D, these activities would be approved. The NPDES-permitted open ocean discharge of produced water would continue under Alternative 3 for most drilling and production activities on the OCS, but there would be no open ocean disposal of any WST-related waste fluids (such as the flowback) or of produced water comingled with the waste fluids. Currently, disposal of produced water varies widely among platforms and platform groupings on the Southern California OCS, even though the NPDES permit allows open water disposal at all the platforms. For example, platforms Irene, Ellen, Elly, and Gail have been reported to inject 94% or more of their produced water (CCC 2013), while other platforms inject less than 15% (Long et al. 2015b). Of the 23 platforms operating on the Southern California OCS, 13 discharge produced water under NPDES General Permit CAG 280000; the others use onshore or offshore injection to dispose of produced water (see Section 4.2.3 and Table 4-2). Under Alternative 3, operators that conduct NPDES-permitted open water discharge of produced water would continue to conduct such open ocean disposal, except that produced water and other waste fluids from the platform that contain WST-related chemicals would need to be removed from the waste stream and disposed of differently (e.g., through injection). Additional injection wells could be needed at one or more of the platforms where waste fluid disposal occurs only via permitted open water discharge.

2.2.4 Alternative 4: No Action—Allow No Use of WSTs

Under this alternative, none of the four WSTs identified for the proposed action would be approved for use in any current or future wells on the 23 platforms associated with active lease areas on the Southern California OCS. However, BSEE technical staff and subject matter experts would continue to review drilling, production, well workover, and routine maintenance on the platforms and their wells and, if determined to be compliant with performance standards identified in BSEE regulations at 30 CFR 250 subpart F, approve these activities. Under Alternative 4, without the use of WSTs, production at some wells may be expected to decline sooner than under the proposed action, as reservoir pressures continue to decline with primary production.

Under Alternative 4, routine well maintenance activities (e.g., wellbore cleanup) and enhanced oil recovery techniques (e.g., water flooding) that fall outside of the SB-4 definition of a WST (see SB-4, Section 3157b) would still continue (as they would under any of the other three alternatives). Wellbore cleanup is routinely conducted on offshore and onshore wells to remove cement residue, drilling mud particles, scale, perforation debris, and other materials that are generated during normal drilling and production activities and may cause formation damage.[5] On the Federal OCS, four wellbore cleaning operations are among 13 routine well maintenance and workover operations conducted at wells with the tree[6] installed, which may not require specific BSEE approval before being commenced on a lease, as identified in 30 CFR 250.105 and 30 CFR 250.601. The four wellbore cleaning operations are the routine well maintenance operations with potential environmental effects; these operations employ chemical agents, such as acids or solvents, or mechanical action, and produce waste residuals requiring disposal: (1) acid wash (a form of acid treatment); (2) solvent wash (a chemical method of cutting paraffin); (3) casing scrape/surge (a method of scale or corrosion treatment and swabbing); and (4) pressure/jet wash (a method of bailing sand and a scale or corrosion treatment). Although well maintenance activities may not require an APM before commencing operations, their use is considered during the plan and development approval stage. In addition, if one of these routine operations requires the removal of the tree, it is no longer considered routine and needs an approved APM before the operation can begin. The four routine wellbore cleaning operations are described below; their potential environmental effects are analyzed in Section 4.5.4.

2.2.4.1 Acid Wash

The removal of some scales, coatings, sludges, and other near-wellbore damage can often be accomplished with an acid soak or wash, and such acid treatments are considered routine operations (30 CFR 250.105). The basic procedure is to pump acid to the perforated completion interval, and allow the acid solution to stand over the completion zone and breakdown scale, sludges, and other materials that may be interfering with hydrocarbon flow into the well. While superficially similar to matrix acidizing, the purpose of an acid wash is for well cleanup and to remove formation damage in the immediate vicinity of the wellbore (which is generally within 20 to 50 inches [50 to 130 cm] from the wellbore), and not to enhance oil production by increasing the permeability of the formation (SB-4). Acid washing is often done on carbonate formations of high permeability to reduce cement and drilling mud damage. The acids used are normally HCl, HCl-HF acid (a mixture of HCl and HF acids), and, less frequently, organic acids such as acetic and formic. The concentration of these acids for a cleanup treatment varies from 3 to 15%.

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5 Formation damage refers to conditions that arise that may affect hydrocarbon flow into a well, primarily by blocking hydrocarbon flow. Formation damage may occur as a result of fines migration, clay swelling, scale formation, organic deposition, and mixed organic and inorganic deposition. Damage may also result from plugging caused by foreign particles in injected fluid, wettability changes, emulsions, precipitates or sludges caused by acid reactions, bacterial activity, and water block.

6 A tree (also commonly known as a Christmas tree) is an assembly of valves, spools, pressure gauges, and chokes fitted to the wellhead of a completed well to control production.

2.2.4.2 Solvent Wash

Instead of an acid treatment, well cleanup can use a broad range of solvents to dissolve and disperse deposits (such as paraffin, asphaltene, and oil sludge) in well bores; diesel, xylene, kerosene, and alcohols are commonly used for this purpose. A solvent wash is a chemical method of cutting paraffin. Treatments are administered as a low-volume soak or a slow injection. Typically, the volume of the treatment is only slightly larger than the tubular volume across the treatment zone. Alcohols and other mutual solvents are used to break emulsions, strip oil coatings, remove water blocks, and alter wettability. Fresh or brine water is often used to remove salt or as a base fluid to carry surfactants, alcohols, mutual solvents, and other products. Hydrocarbon solvents regularly used include crude oil and condensate, as well as refined oils such as diesel, kerosene, xylene, and toluene. Solvents are often effective where acid has little or no effect on the deposits.

2.2.4.3 Casing Scrape/Surge

Casing scrape/surge is a form of scale or corrosion treatment as well as a form of swabbing. Mechanical casing scraping is used to remove drill mud solids, mill scale, cement, and corrosion particulates in wellbores, particularly in cases of severe sludge buildup. Scraping may be used to remove paraffin or barium sulfate scale, which can restrict the flow of oil, from well tubes. Scraping or other mechanical removal may be required when chemical treatment (i.e., acid or solvent wash) is not effective, such as when scale occurs as nearly pure deposit or as thick (>1/4 in., 6 mm) deposits in pipes.

2.2.4.4 Pressure/Jet Wash (water blasting)

A pressure/jet wash is a method of bailing sand, as well as a scale or corrosion treatment. In instances of severe sludge buildup, high-pressure water jetting may be used to clean out sand or fill. Water nozzles are lowered into the well where the buildup is located, and the sand is then removed by the high-pressure water. Water-blasting tools may also be used in gypsum deposit removal from tubing, especially when deposits are thickly encrusted.

2.2.5 Alternatives Considered but Eliminated from Further Evaluation

A number of other alternatives were considered but eliminated from further evaluation in this EA. For these, the potential underlying concerns for their initial consideration were related to reducing the likelihood of either an accidental surface expression of hydrocarbon or an accidental release of WST-related chemicals, or to reducing the potential toxic effects of WST-related fluids. However, upon consideration it was determined that none of these alternatives would avoid or substantially lessen any potential effects of WST use on the Southern California OCS beyond those already considered in the four alternatives carried forward for analysis in this EA.

2.2.5.1 Allowing Use of WSTs Subject to Injection Pressure Stipulations

Under this alternative, BSEE technical staff and subject matter experts would continue to review the use of WSTs included in the proposed action and, if determined to be compliant with performance standards identified in BSEE regulations at 30 CFR 250 subpart D, these activities would be approved. However, the use of any of the fracturing WSTs (which require injection pressures above the existing reservoir pressure) would be subject to stipulations identifying maximum injection pressures that could be used during fracturing. The intent of such pressure stipulations is to reduce the potential for unexpected fracturing or for damaging a well bore casing, each of which could result in a seafloor surface expression of WST injection fluids and hydrocarbons.

Pressures needed for fracturing WST operations are based on the specific geology of the formation, the specific wellbore at which the WST would be implemented, and the completion design; therefore it is not possible to identify a pressure stipulation that would be appropriate and applicable for all WSTs, wells, and formations. For example, a deep fracture operation may need a much larger injection pressure to overcome hydrostatic pressure than would a shallow operation, even if the planned fracture half-wing length is the same for both operations. All downhole wellbore operations must use pressure-tested lines and tubing and casing that is rated (with a safety factor usually 70%) to handle the planned pressures of the operation and comply with BSEE regulations (see 30 CFR 250 subpart D, Oil and Gas Drilling Operations). During a fracturing WST, the highest pressure buildup is the fracture initiation pressure, after which the pressure drops off. While injection pressures for fracturing vary greatly depending on individual circumstances (e.g., the formation structure and reservoir pressure), injection pressures must always be within BSEE regulations (as all wellbore operations must be, not just those unique to fracturing operations).

Because of the existing BSEE pressure rating requirements for all wells and associated equipment, an alternative with injection pressure stipulations above and beyond pressure requirements as specified in BSEE regulations (30 CFR 250 subpart D) would provide no added protection against damaging a well bore casing. In addition, because of the case-by-case specificity of required pressures for a fracturing WST, it is unlikely that any single pressure stipulation would be applicable or appropriate for all fracturing WST cases. Thus, this alternative was dropped from further evaluation.

2.2.5.2 Allow Use of WSTs Subject to Fracturing Fluid Volume Stipulations

This alternative would limit the total volume of injected fluid to 250,000 gal (5,952 bbl) for a complete fracturing WST and thus potentially decrease the likelihood and magnitude of an accidental seafloor surface expression of WST chemicals to the environment during injection. Each of the fracturing WSTs included in the proposed action involves the injection of a fracturing fluid, which typically is more than 99.5% filtered seawater and proppant (if used) and 0.5% WST fracturing chemicals (Tormey 2014). Fracturing WSTs are typically conducted in multiple stages, each with a given injected volume of fluid. During each stage, the WST chemicals (which are stored on the platform) are mixed with the filtered seawater during injection; a fracturing job may consist of up to four or more stages, each injecting up to about 60,000 gal (about 1,430 bbl).

Historically, on the Southern California OCS the total volume of fracturing fluid used to complete a fracturing WST has ranged from as little as 2,000 gal (48 bbl) up to 177,000 gal (4,200 bbl) (BOEM 2015; Long et al. 2015b). To date, the largest total volume of WST fluids used on any of the 23 platforms on the Southern California OCS was for a fracturing operation (at Platform Gail in 2010) and did not exceed 180,000 gal (4,290 bbl) (BOEM 2015). By comparison, fluid volumes used in offshore platforms and production facilities in State waters have ranged from about 3,000 to 210,000 gal (71 to 5,000 bbl) (Long et al. 2015b). Current total volume expectations for future WST operations (based on past and reasonably foreseeable future operations) at platforms on the Southern California OCS are around 240,000 gal (about 5,720 bbl), assuming no more than four stages in a wellbore and 60,000 gal (1,430 bbl) per stage.

Limiting the total volume of injected fluid for a complete fracturing WST was considered as a potential means of decreasing the likelihood of an accidental release of WST chemicals (i.e., the fewer stages per completion, the fewer chances there are for an accidental release to occur over the entire completion). However, the greatest potential for an accidental release of WST chemicals into the environment is from an accident involving an individual storage tank on the platform (see Section 4.3), the volume of which is independent of the total injection volume of the fracturing WST. An alternative stipulating an injection volume would not avoid or substantially lessen the potential for an accidental release of WST chemical from a platform accident, or limit the magnitude of a potential accidental platform release of the WST chemicals. Thus, this alternative was dropped from further evaluation.

2.2.5.3 Allowing Use of WSTs Subject to Stipulations on Injection Fluid Chemical Constituents, Such as Limiting Use of Bioaccumulative Compounds or Strong Acids

Some WSTs use chemicals and strong acids with potentially toxic or corrosive properties. An alternative was considered that would limit or prohibit the use of some chemical constituents of the fracturing fluids, thereby limiting the potential for adversely affecting water quality and marine biota during disposal of WST-related waste fluids to the open ocean. Ocean discharge from platforms and production facilities in California State waters is prohibited under State law. In contrast, ocean discharge of produced water and other waste fluids from platforms in Federal waters of the Southern California OCS is not prohibited. It is regulated, however, by the EPA's NPDES permit program, which controls water pollution by regulating point sources (including operating platforms) that discharge into waters of the United States. Specifically, routine discharges from platforms (which is where environmental exposure to any WST-related chemicals would likely first occur) on the Southern California OCS are regulated by NPDES General Permit CAG280000. This permit covers six categories of discharges (drilling fluid and cuttings; produced water; well treatment, completion, and workover fluids; deck drainage; domestic and sanitary wastes; and 17 miscellaneous other discharge categories) and includes required monitoring and toxicity testing of all surface discharges from the platforms.

WST fluids fall within the well treatment, completion, and workover fluids category of the NPDES permit. In developing the current NPDES permit strategy, the EPA determined "…it is not feasible to regulate separately each of the constituents in well treatment, completion and workover fluids because these fluids in most cases become part of the produced water waste stream and take on the same characteristics of produced water. Due to the variation in the types of fluids used, the volumes used and the intermittent nature of their use, EPA believes it is impractical to measure and control each parameter" (EPA 1995).

Following their use in a WST at a well, acids will be largely chemically consumed and neutralized, and associated waste fluids would be collected, comingled, and diluted with produced water from the well. This WST waste fluid-produced water mixture would then be further diluted when combined with produced water from other wells at the platform, and possibly further diluted if combined with the produced water waste stream from other platforms (as occurs at some platforms; see Section 4.2.3). This produced water with highly diluted WST-related waste chemicals would then be treated prior to any permitted open ocean discharge. A portion of non-acid WST chemicals (over 90% in the case of hydraulic fracturing WSTs [see Section 4.5.1.3]) is retained in the formation and is not recovered or recovered slowly in waste fluids. As with WST acids, non-acid WST chemicals collected in the waste stream from a well would be similarly diluted and treated prior to any permitted release to the ocean.

To ensure protection of water quality and marine biota, the NPDES permit for the OCS platforms identifies concentration limits at the boundary of a 100-m (328-ft) mixing zone around the discharge point, and no effects on water quality are expected beyond the mixing zone (see Section 4.5.1.3). To address potential toxicity of unspecified WST constituents in discharges, the NPDES permit requires quarterly whole effluent toxicity (WET) testing of produced water, which would include any WST-related fluids and chemicals. The WET tests evaluate chronic toxicity of the produced water and thus captures the cumulative risk of exposure to groups of chemicals, which is how environmental exposure would occur (exposure would not be on a chemical-by-chemical basis, but rather would be simultaneous to a mixture of all chemical constituents in the discharged water).

At a well undergoing a WST, all WST waste fluids are highly diluted through mixing with produced water from multiple wells and are subsequently treated prior to discharge. The NPDES permit regulating ocean discharge from the platforms (which is where exposure to WST-related chemicals would first occur) includes concentration limits for protecting water quality as well as WET testing for evaluating the chronic toxicity of the contaminant mixture in the permitted discharge. Because waste fluids containing WST-related chemicals would be highly diluted and then treated prior to any permitted open ocean discharge, and because of required compliance with the NPDES permit concentration limits and WET toxicity testing, an alternative limiting the use of some chemicals would be expected to provide little further protection to water quality and marine biota beyond that provided under the NPDES permit currently regulating platform discharges on the OCS. If analysis of the alternatives finds impacts on water quality or marine biota due to the presence of certain WST-related chemicals, then at that point further alternatives could be developed that limit the use those WST chemicals that contributed to the impacts.

2.3 ENVIRONMENTAL RESOURCES CONSIDERED IN THIS ENVIRONMENTAL ASSESSMENT

Based on a review of the environmental resources and of socioeconomic and sociocultural (including environmental justice) conditions present in the vicinity of the platforms on the Pacific OCS, together with the anticipated operational features of the WSTs included in the proposed action, the following resources and conditions were determined to be in the vicinity of the platforms and could potentially be affected by the proposed action, and thus were evaluated in this EA:

- *Air quality*: Potential impacts due to contributions to elevated photochemical ozone from ozone precursor emissions such as nitrogen oxides (NO_x) and/or volatile organic compounds (VOCs) from diesel pumps and support vessels (crew transport and materials delivery) associated with WST activities; contributions to visibility degradation from emissions of particulate matter (PM) (e.g., elemental carbon [EC], organic carbon [OC]) and/or its precursors (e.g., NO_x, sulfur oxides [SO_x]) from WST activities; and climate change (albeit small) due to greenhouse gas emissions such as carbon dioxide (CO_2) and methane (CH_4) associated with WST activities. Air quality may be similarly affected by emissions during drilling of new injection wells that may be needed as a result of Alternative 3.

- *Water quality:* Potential impacts of routine WST operations on water quality and marine life within the 100-m radius mixing zone defined under the U.S. Environmental Protection Agency (EPA) National Pollutant Discharge Elimination System (NPDES) general permit from WST waste fluids in permitted discharges to the ocean; compliance with the provisions of the permit would prevent effects outside the mixing zone; potential impacts on water quality from the release of WST fluids or hydrocarbons from potential accidents. Temporary and localized decreases in water quality that may occur as a result of bottom- disturbing activities that may occur under Alternative 3.

- *Geologic resources/seismicity*: While impacts on geologic resources are not expected from the proposed action, there is concern that some WSTs may stimulate seismic activity in seismically active areas such as the Santa Barbara Channel, and thus result in an increase in seismic hazard in the vicinity of the wells where fracturing WSTs are being implemented.

- *Benthic resources (including special status species)*: Potential lethal, sublethal, or displacement impacts on benthic communities following ocean disposal of WST waste fluids or the accidental release of WST fluids, and the accidental discharge of hydrocarbons from a fault or damaged wellhead; and contamination of Endangered Species Act (ESA)-designated critical habitat with hydrocarbons and fracturing fluids following an accidental release. Benthic resources may also be affected by bottom-disturbing activities associated with Alternative 3.

- *Marine and coastal fish (including special status species) and essential fish habitat*: Potential lethal, sublethal, or displacement impacts on fish following ocean disposal of WST waste fluids or the accidental release of WST fluids, and the accidental discharge of hydrocarbons from a fault or damaged wellhead; contamination of Essential Fish Habitat (EFH) and ESA-designated critical habitat with hydrocarbons and fracturing fluids following an accidental release. Marine and coastal fish may also be affected by bottom-disturbing activities that may occur as a result of Alternative 3.

- *Marine and coastal birds (including special status species)*: Potential lethal or sublethal effects following ocean disposal of WST waste fluids or the accidental release of WST fluids, and the accidental discharge of hydrocarbons from a fault or damaged wellhead.

- *Marine mammals (including special status species)*: Potential lethal or sublethal effects following ocean disposal of WST waste fluids or the accidental release of WST fluids, the accidental discharge of hydrocarbons from a fault or damaged wellhead; and vessel strikes, noise, and other disturbances associated with WST operations. Marine mammals may also be affected by noise from bottom-disturbing activities that may occur as a result of Alternative 3.

- *Sea turtles*: Potential lethal or sublethal effects following ocean disposal of WST waste fluids or the accidental release of WST fluids; the accidental discharge of hydrocarbons from a fault or damaged wellhead; and vessel strikes, noise, and other disturbances associated with WST operations. Sea turtles may also be affected by bottom-disturbing activities that may occur as a result of Alternative 3.

- *Commercial and recreational fisheries*: Potential impacts due to preclusion from fishing areas due to interference with vessels transporting WST materials and equipment, localized closure of fisheries due to accidental release of WST fluids or of improperly treated wastewater, and reduced abundance of fishing resources due to exposure to accidental release or routine disposal of WST fluids.

- *Areas of Special Concern*: Potential impacts if water quality is affected; some biological resources potentially affected as identified above.

- *Recreation and Tourism*: Potential impacts if area water quality is affected and use of or access to recreational areas is affected.

- *Environmental Justice*: No disproportionate impacts to minority and low-income populations anticipated even following accidental release of WST fluids and waste fluids.

- *Archaeological Resources*: Archaeological resources are most at risk from oil and gas (O&G) activities that physically disturb the seafloor. Because none of the WSTs included in the proposed action involve seafloor-disturbing activities, the proposed action would not affect Archaeological resources. However, bottom-disturbing activities that may occur under Alternative 3, affecting Archaeological resources where new injection wells could be needed.

- *Socioeconomics:* No impacts expected from the use of WSTs, while some impacts may occur with a WST-related accident.

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3 AFFECTED ENVIRONMENT

3.1 INTRODUCTION

The proposed action would apply to oil and gas (O&G) operations and activities within 43 existing Federal leases in the Southern California OCS Planning Area. In this planning area,14 oil and gas fields are currently being produced by 23 structures (22 producing and one processing); 15 structures are located offshore of Santa Barbara County, four structures offshore of Ventura County, and four structures offshore Long Beach, near the boundary of Los Angeles County and Orange County (Aspen Environmental Group 2005) (Figure 3-1). Descriptions of the platforms are presented in Table 3-1). The 23 platforms on the Southern California OCS occur in water depths ranging from about 95 to 1,200 ft (29 to 366 m), and they are about 3.7 to 10.5 mi (6 to 17 km) from shore. For the purposes of this EA, the 43 lease areas where WSTs may be carried out represent the project area for the proposed action. The geographic range of the potential effects extends beyond the project area to areas where effects could occur from activities within the project area.

3.2 GEOLOGY AND SEISMICITY

3.2.1 Regional Description and Physiography

The portion of the Southern California OCS Planning Area from just north of Point Sal to the United States–Mexico border largely coincides with the physiographic region known as the California Continental Borderland (Gorsline and Teng 1989). This region is a complex of basins, ridges, islands, and banks that make up the boundary between the Pacific and North American tectonic plates (Given et al. 2015). These features follow the northwest–southeast trend of the Peninsular Ranges in the south, the east–west trend of the Transverse Range in the Santa Barbara–Ventura Basin and the northwest trending southern Coast Ranges in the northernmost part of the area. Structurally, the region is a sequence of elongated thrust blocks separated by major faults. Numerous offshore basins have been identified in this region, including the offshore Santa Maria, Santa Barbara–Ventura, and San Pedro Basins, where oil and gas well platforms on the Federal OCS are currently in operation (Figure 3-2).

The submerged part of the California Continental Borderland covers an area of about 27,000 mi^2 and has a length of about 560 mi. Its maximum width from shore to the base of the Patton Escarpment (the seaward edge of the continental shelf) is about 155 mi; this occurs at the latitude of the United States–Mexico border (Gorsline and Teng 1989).

3.2.2 Geology of the Santa Maria Basin

The offshore portion of the Santa Maria Basin, shown in Figure 3-3, lies within the Central California province (Figure 3-2). It is a northwest-trending basin that extends from about

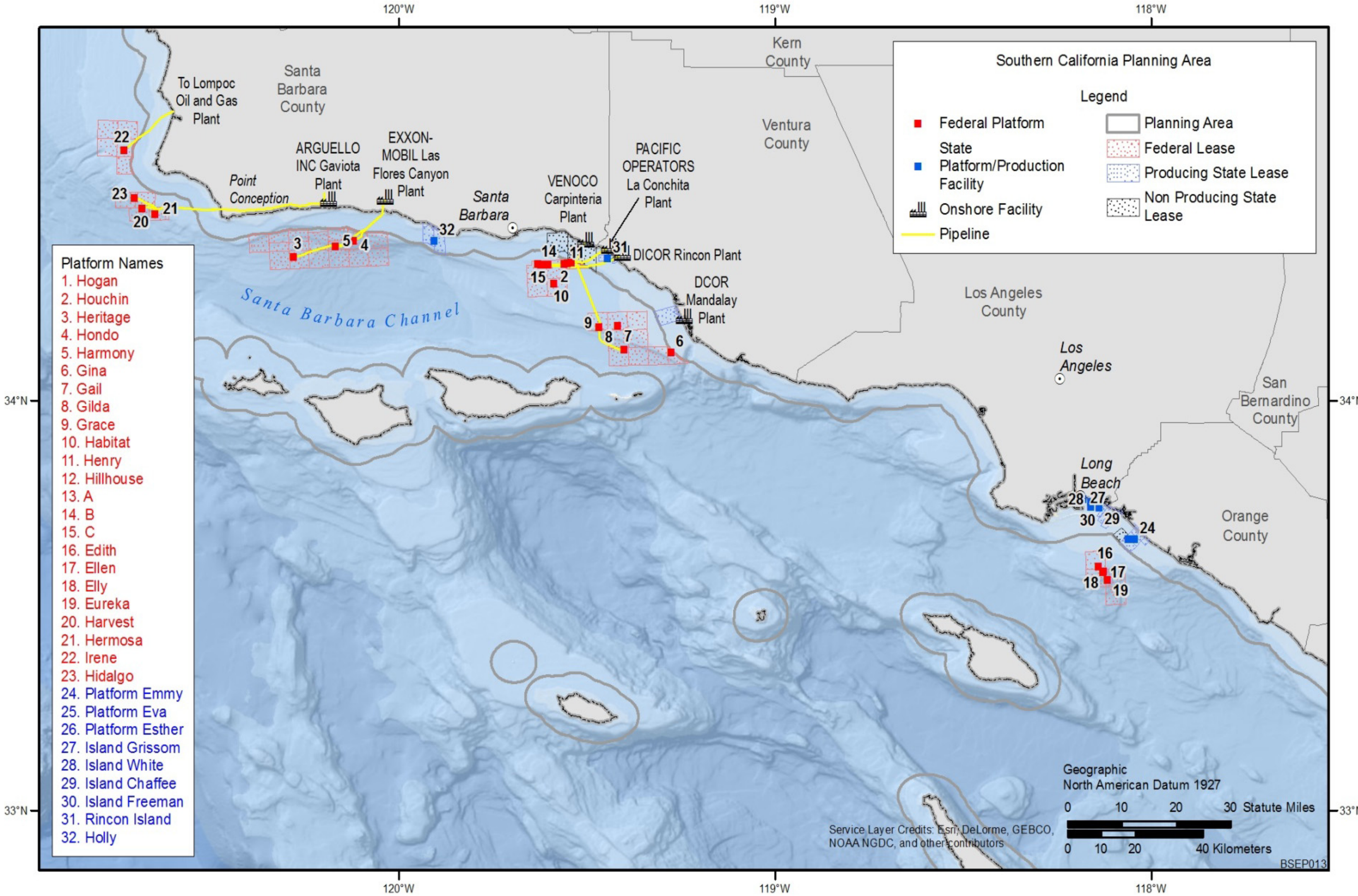

FIGURE 3-1 Locations of Current Lease Areas, Platforms, and Pipelines of the Southern California OCS Planning Area (Also shown are platforms and production facilities in offshore State waters adjacent to the Federal OCS. Platforms in Federal waters are shown in red, and those in State waters are shown in blue.)

TABLE 3-1 Production and Processing Platforms on the Southern California Outer Continental Shelf

Platform	Date Installed	Location	Operator	Water Depth (ft)	Distance from Shore (mi)	No. of Well Slots[a]
Tranquillon Ridge Field						
Irene	8-7-1985	Santa Maria Basin	Freeport-McMoRan Oil & Gas, LLC	242	4.7	72
Point Arguello Field						
Harvest	6-12-1985	Santa Maria Basin	Freeport-McMoRan Oil & Gas, LLC	675	6.7	50
Hermosa	10-5-85	Santa Maria Basin	Freeport-McMoRan Oil & Gas, LLC	603	6.8	48
Hidalgo	7-2-86	Santa Maria Basin	Freeport-McMoRan Oil & Gas, LLC	430	5.9	56
Hondo Field						
Hondo	6-23-76	Santa Barbara Channel	ExxonMobil Corporation	842	5.1	28
Harmony	6-21-89	Santa Barbara Channel	ExxonMobil Corporation	1,198	6.4	60
Pescado Field						
Heritage	10-7-89	Santa Barbara Channel	ExxonMobil Corporation	1,075	8.2	60
Carpinteria Offshore						
Houchin	7-1-1968	Santa Barbara Channel	Pacific Operators Offshore, LLC	163	4.1	60
Hogan	9-1-1967	Santa Barbara Channel	Pacific Operators Offshore, LLC	154	3.7	66
Henry	8-31-1979	Santa Barbara Channel	DCOR, LLC	173	4.3	24
Dos Cuadras Field						
Hillhouse	11-26-1969	Santa Barbara Channel	DCOR, LLC	190	5.5	60
A	9-14-1968	Santa Barbara Channel	DCOR, LLC	188	5.8	57
B	11-8-1968	Santa Barbara Channel	DCOR, LLC	190	5.7	63
C	2-28-1977	Santa Barbara Channel	DCOR, LLC	192	5.7	60
Pitas Point Field						
Habitat	10-8-1981	Santa Barbara Channel	Pacific Operators Offshore, LLC	290	7.8	24
Santa Clara Field						
Gilda	1-6-1981	Santa Barbara Channel	DCOR, LLC	205	8.8	96
Grace	7-30-1979	Santa Barbara Channel	Venoco, Inc.	318	10.5	48

TABLE 3-1 (Cont.)

Platform	Date Installed	Location	Operator	Water Depth (ft)	Distance from Shore (mi)	No. of Well Slots[a]
Sockeye Field						
Gail	4-5-1987	Santa Barbara Channel	Venoco, Inc.	739	9.9	36
Hueneme Field						
Gina	12-11-1980	Santa Barbara Channel	DCOR, LLC	95	3.7	15
Beta Field						
Edith	1-12-1984	Offshore Long Beach, CA	DCOR, LLC	161	8.5	72
Elly	3-12-80	Offshore Long Beach, CA	Beta Operating Company, LLC	255	8.6	NA[b]
Ellen	1-15-80	Offshore Long Beach, CA	Beta Operating Company, LLC	265	8.6	80
Eureka	7-8-1984	Offshore Long Beach, CA	Beta Operating Company, LLC	700	9.0	60

[a] A well slot is an opening in the platform through which a developmental well can be drilled. The greater the number of well slots on a platform, the greater the number of developmental wells that can be drilled from the platform.

[b] Platform Elly is a processing facility.

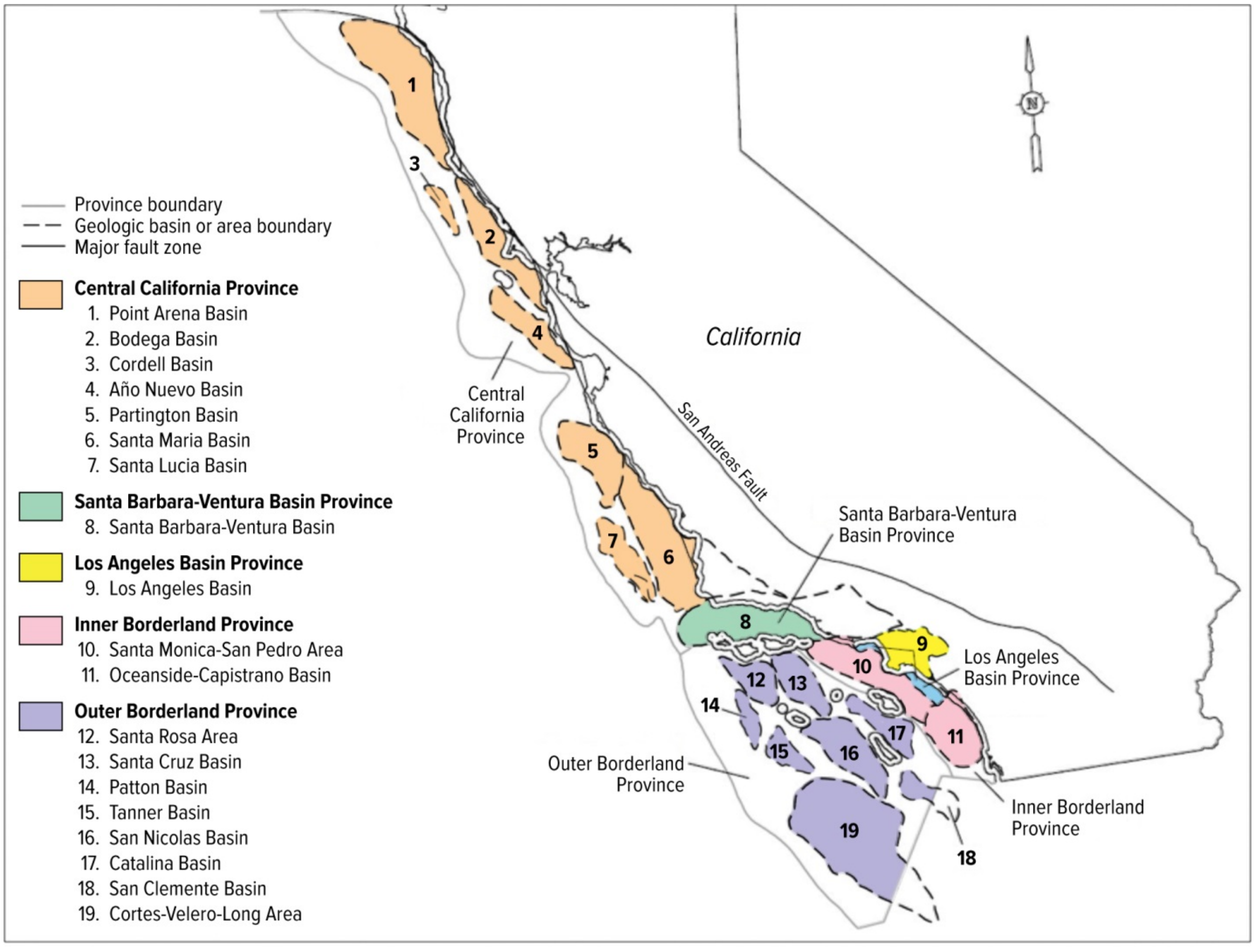

FIGURE 3-2 Map of the Pacific OCS Region Showing the Offshore Geologic Basins (MMS 1997)

Point Arguello northward to Point Piedras Blancas (Mayerson 1997; BOEM 2014). It is bounded on the east by the Hosgri Fault Zone, on the west by the Santa Lucia Bank Fault, and by structural highs to the north and south. The basin is about 100 mi long and 25 mi wide and covers an area of about 2,500 mi^2. Water depths range from 300 ft near Point Sal to 3,500 ft in the southwestern part of the basin.

The Santa Maria Basin experienced rapid subsidence as a result of regional extension during the early Miocene. Normal-faulting of basement blocks formed sub-basins that are filled with volcanic rocks and biogenic and clastic sediments of Miocene and Pliocene age. In the early Pliocene, uplift and structural inversion of the basin reactivated the normal faults and caused folding of the Miocene and Pliocene strata into anticlines[1] that are traps for much of the oil in the basin (Mayerson 1997).

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1 An anticline is a geologic structure created by compressional stress and comprised of folded strata, convex up, with the oldest beds at its core.

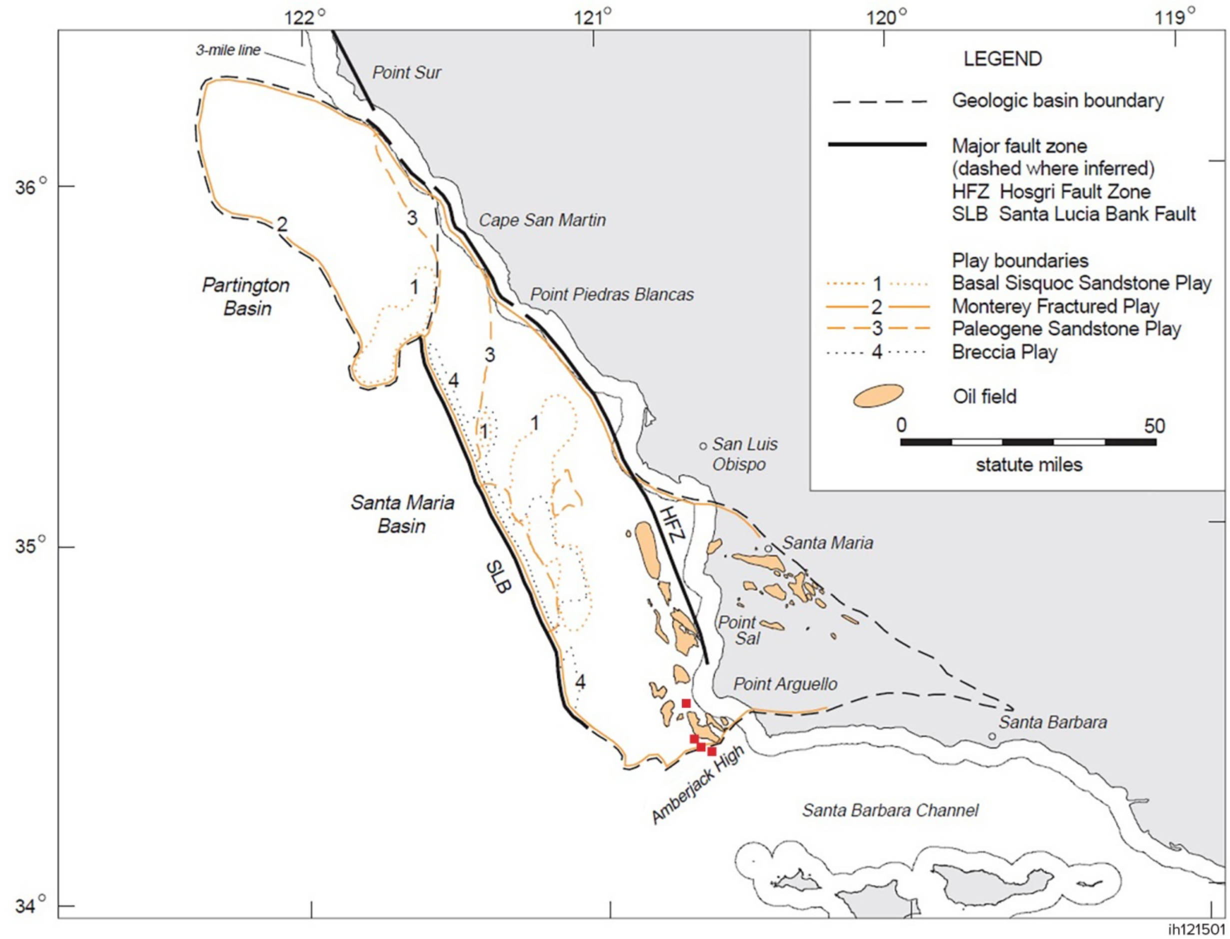

FIGURE 3-3 Location, Geologic Plays, and Oil Fields of the Santa Maria Basin (Platforms in Federal waters are shown in red.) (Modified from Mayerson 1997)

3.2.2.1 Stratigraphy

The stratigraphy of the Santa Maria Basin is shown in Figure 3-4. Logs of exploratory wells drilled in the southern and central portions of the offshore basin (most bottoming in basement rocks of the Jurassic Franciscan Complex) show Paleogene rocks are missing in most wells.

The first exploratory well was drilled in the offshore Santa Maria Basin in 1964. The well, located about 15 mi northwest of Point Sal, had abundant shows of oil in the Monterey Formation. Since 1980, when the first discovery well was drilled at the Point Arguello field, the Monterey Formation has been the primary exploration target in the basin (Mayerson 1997). Four of the 14 producing fields in the Pacific OCS Region are in the offshore Santa Maria Basin (Point Arguello, Rocky Point, Tranquillon Ridge, and Point Pedernales fields).

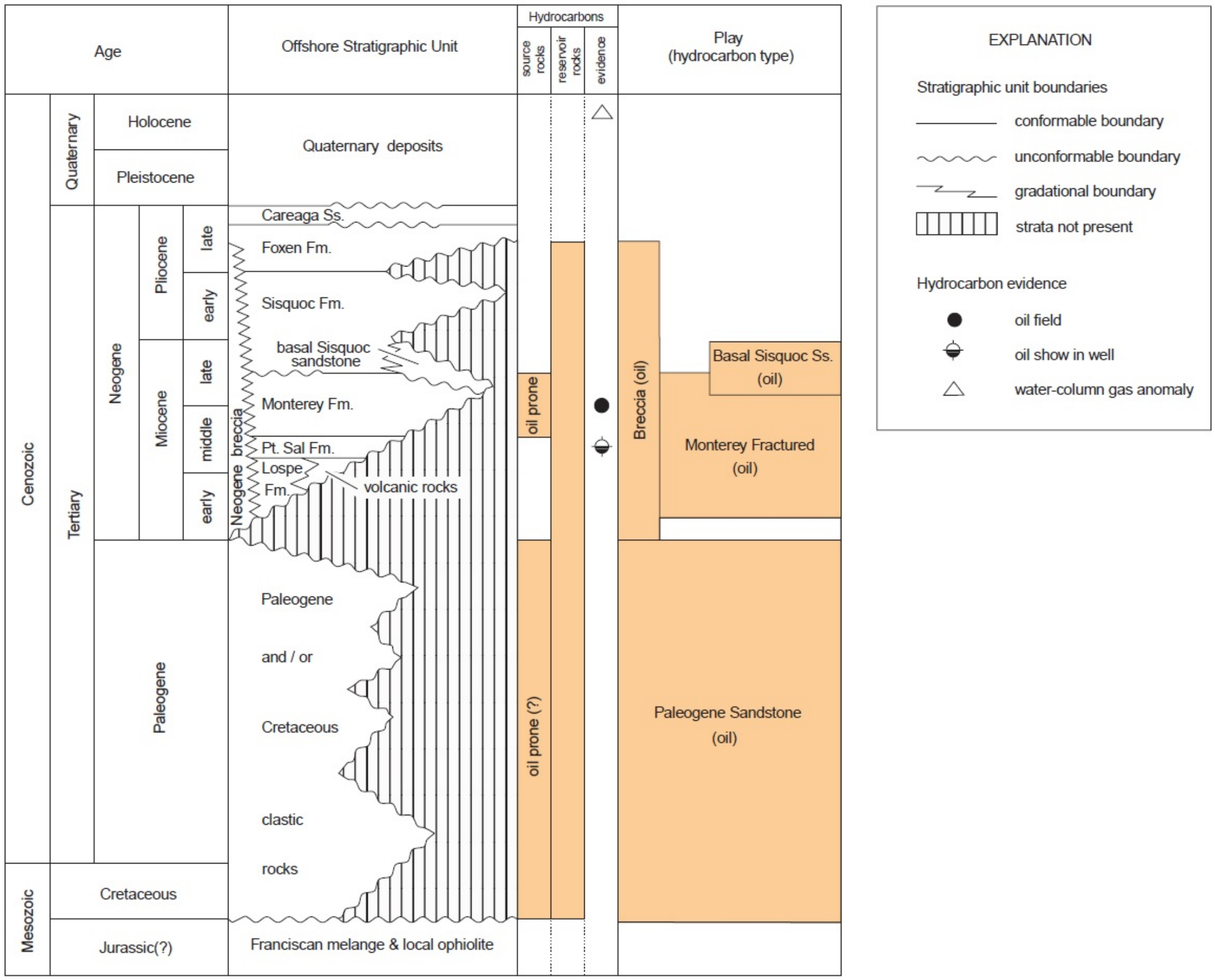

FIGURE 3-4 Stratigraphy of the Santa Maria Basin (Mayerson 1997)

The Monterey Formation. The vast majority of petroleum production in the offshore Santa Maria Basin comes from the Monterey Formation. The Monterey Formation is most productive where it has been diagenetically altered to highly fracturable quartz, and in shallower areas, opal-CT (crystobalite/tridymite). This play is established both onshore and offshore. The primary source rock for the play is the organic-rich shales and phosphatic rocks of the Monterey Formation itself (Mayerson 1997; Figure 3-4).

Reservoirs in the Monterey Formation include oil and associated gas accumulations in fractured siliceous and dolomitic rocks of the middle and upper Miocene (Figure 3-4). In the entire offshore Santa Maria Basin, the Monterey Formation covers an area of about 3,800 mi^2 and occurs at burial depths of about 0 (exposed on the seafloor) to 11,000 ft (Figure 3-3). The Monterey Formation is its own source and reservoir rock. Researchers report that total organic carbon content of the formation ranges from 3 to 17%. Minor reservoir rocks also include sandstones of the Point Sal and Lospe Formations (Figure 3-4). As mentioned above, the quality of the reservoir is thought to be controlled by the diagenetic grade of its siliceous strata, with the best reservoirs having been diagenetically altered from opal-CT) to quartz, because of the increased fracture density associated with quartz-phase strata (Isaacs 1992; Mayerson 1997). This diagenetic boundary has been correlated with a seismic reflector than can be traced throughout much of the offshore basin. Traps in the offshore Santa Maria Basin producing reservoirs are primarily structural and occur in faulted and/or fault-bounded anticlines. Many of the fields discovered in the central portion of the offshore basin and, therefore, are associated with fault zones, especially along the basin's eastern boundary (Figure 3-3; Mayerson 1997).[2]

3.2.2.2 Potential for Application of WST

The most recent estimate of remaining oil and gas reserves in the four fields of the offshore Santa Maria Basin are approximately 42 million bbl of oil and 61 billion ft^3 of gas (BOEM 2014). WST, via hydraulic fracturing, currently has limited applicability because the Monterey Formation reservoirs producing in the basin are already naturally fractured. Onshore, WST (i.e., hydraulic fracturing) of the vast areas of the Monterey Formation has had only marginal success. Therefore, WST is expected to be incidental rather than fundamental to the development of these basins (Long et al. 2015).

3.2.3 Geology of the Santa Barbara–Ventura Basin

The Santa Barbara–Ventura Basin is located both onshore and offshore southern California (Figure 3-5). The depositional basin is bounded to the north by the Santa Ynez and related faults; to the east by the San Gabriel fault; to the south by a series of thrust faults and lateral faults related to the Malibu Coast-Santa Monica fault zone, the Santa Cruz Island fault, and the Santa Rosa fault; and to the west by the Amberjack High, a poorly defined basement trend that lies between Point Conception and Point Arguello (Figure 3-5). The submerged (offshore) portion of the basin, shown in green in Figure 3-5, is designated as the Santa Barbara–Ventura Basin province in MMS (1997). It is about 90 mi long and 20 mi wide and covers an area of about 1,800 mi^2. The province is commonly referred to as the Santa Barbara Channel (Galloway 1997; BOEM 2014).

3.2.3.1 Stratigraphy

Petroleum seeps in the Santa Barbara Channel have been exploited since prehistoric times. At least 155 oil and gas fields have been discovered since 1861, 33 of which were discovered before 1901. The first offshore oil wells in North America were drilled in the Summerland field in 1894; the first Federal lease in the channel was issued in 1966 (Galloway 1997). Currently, nine fields (Hondo, Hueneme, Pescado, Pitas Point, Sacate,

[2] Although there are only three producing fields in the offshore Santa Maria Basin, many more discoveries have been made and economically viable fields have been delineated. The leases on which these fields are located were the subject of litigation and ultimately bought back by the government.

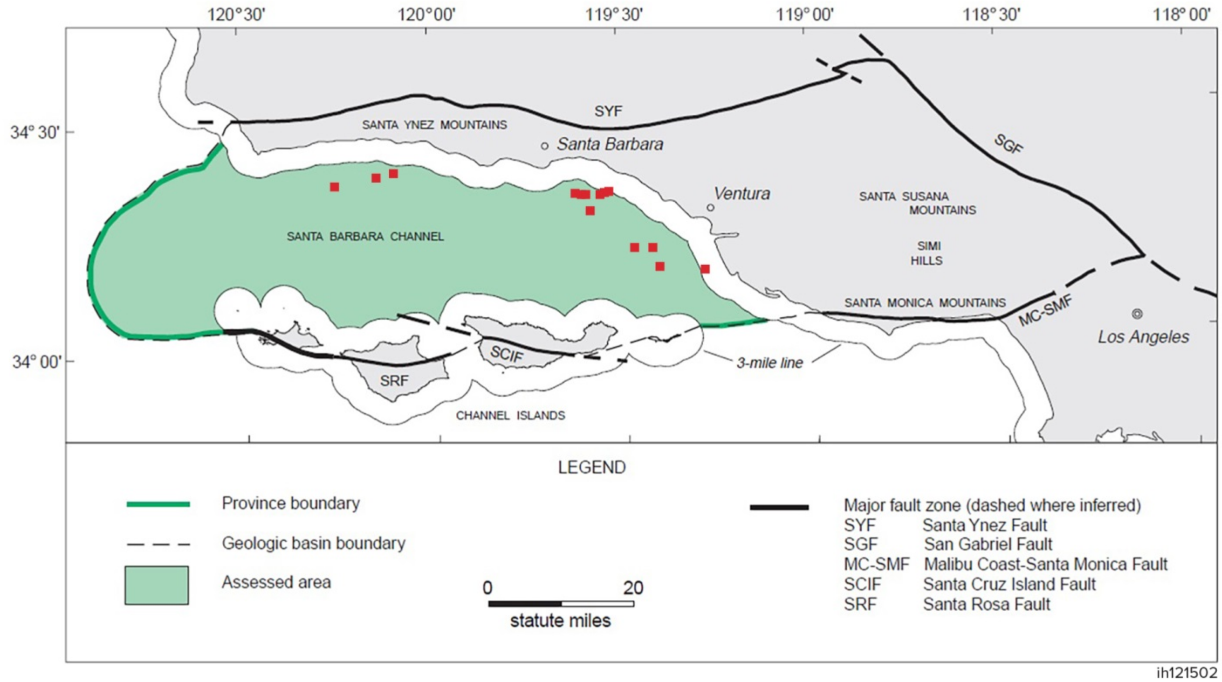

FIGURE 3-5 Location of the Santa Barbara–Ventura Basin (Platforms in Federal waters are shown in red.) (Modified from MMS 1997)

Dos Cuadras, Carpinteria, Sockeye, and Santa Clara) are in production. Together, these fields are estimated to contain reserves of almost 220 million bbl of oil and 500 billion ft^3 of gas.

Oil and gas reservoirs have been identified in nearly every formation in the Santa Barbara Channel. The major producing reservoirs in the Santa Barbara–Ventura Basin are listed in Table 3-2 along with the fields in which they produce.

Pico-Repetto Sandstone. The Pico-Repetto Sandstone is an established O&G play that includes known and prospective oil and gas accumulations in Pliocene and early Pleistocene reservoirs. Although Pliocene strata are distributed throughout the basin, the Federal offshore portion of the play is limited to the eastern part of the basin where reservoir sandstones are abundant and depositional thickness is greater than 2,000 ft. Where this formation occurs in the Santa Barbara–Ventura Basin, it covers an area of about 400 mi^2. Reservoir rocks are mainly sandstones of the Repetto and Pico Formations (Figure 3-6); these compose over 50% of the rock volume in parts of the play. The Repetto Formation is reaches thicknesses in excess of 4,000 ft in parts of the basin and the Pico Formation has a maximum thickness exceeding 10,000 ft.

The Monterey Formation is the likely source rock for O&G in the Pico-Repetto play; deeply buried lower Pliocene claystones and mudstones may be another source (although whether the Pliocene section is thermally mature is uncertain). Traps are predominantly structural (anticlines, faulted anticlines, and fault blocks), with less common stratigraphic traps also occurring along unconformities on the flanks of folds and permeability barriers.

TABLE 3-2 Major Producing Formations and Associated Fields on the Southern California OCS

Formation	OCS Field
Pico	Carpinteria
Repetto	Carpinteria, Dos Cuadras, Pitas Point, Santa Clara
Monterey	Hondo, Pescado, Sacate, Santa Clara, Sockeye
Topanga	Sockeye
Hueneme	Hueneme, Sockeye
Vaqueros	Hondo
Sespe	Hueneme, Santa Clara, Sockeye

Monterey Formation. The Monterey Formation is an established play that includes known and prospective oil accumulations in middle to late Miocene reservoirs. The Monterey Formation is distributed throughout the basin. Reservoir rocks of the play are fractured zones formed by silica diagenesis (which causes the rock mass to become increasingly brittle) and late Neogene compressional tectonics.

The Monterey Formation is its own source rock; traps within the play are predominantly complexly faulted anticlines but also include normal- and thrust-faulted blocks.

Topanga Sandstone. The Topanga Sandstone is an established play that includes known and prospective oil and associated gas accumulations in early to middle Miocene reservoirs. Reservoir rocks of the play are primarily sandstones with good porosity (20–30%) and good permeability (400 to 600 millidarcies). Sandy zones may be thicker than 1,000 ft.

Source rocks are the Monterey Formation and, locally, the clay shales of the Rincon Formation. Traps are predominantly structural (faulted anticlines), but may also contain important stratigraphic elements (e.g., channel sandstones).

Sespe, Hueneme and Vaqueros Sandstones. The Sespe, Hueneme, and Vaqueros sandstones are an established play that include known and prospective accumulations of oil and associated gas (and non-associated gas)[3] in reservoirs of late Eocene and Oligocene to early Miocene age. Reservoir rocks are coarse nonmarine and marine clastics of the Sespe Formation and shallow marine sandstones of the coeval Alegria Formation (Figure 3-6). The shallow marine and fan deposits of the Hueneme and Vaqueros sandstones represents a nearshore to shelf deposit and, locally, submarine canyon fill. The Sespe, Hueneme, and Vaqueros section is more than 7,500 ft thick in parts of the basin but averages about 3,000 to 4,000 ft.

3 Non-associated gas is typically a local phenomenon and likely is sourced from land-derived woody or coaly debris deposited in a shallow marine or continental-marine transitional environment.

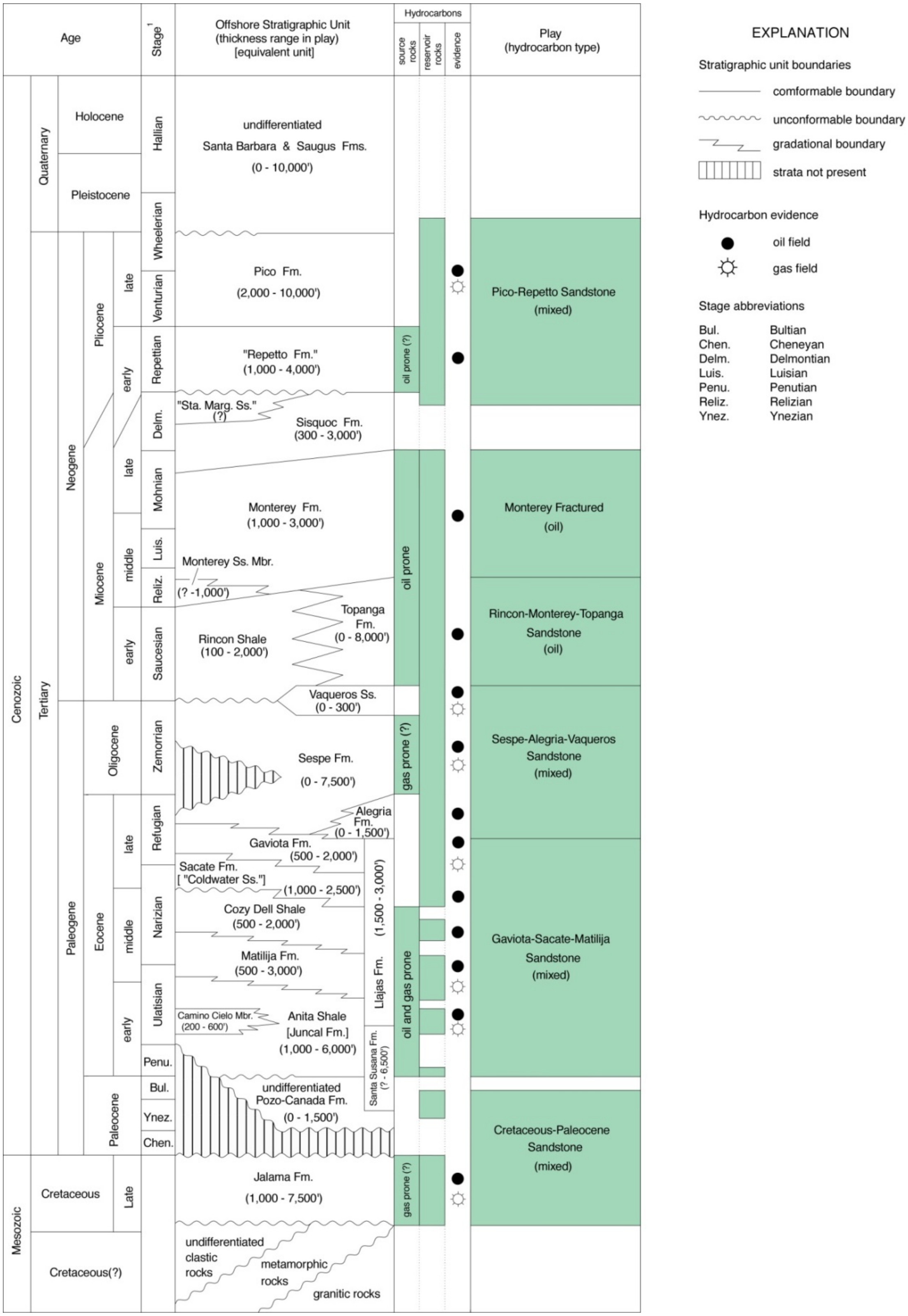

FIGURE 3-6 Major Producing Formations in the Santa Barbara–Ventura Basin and the Fields from Which They Produce (Modified from MMS 1997)

Source rocks are likely the Eocene deep-water shales and overlying Miocene formations; traps are most commonly structural (anticlines, faulted anticlines, and fault blocks), but may contain important stratigraphic elements.

3.2.3.2 Potential for Application of WST

As stated above for the offshore Santa Maria Basin, WST, via hydraulic fracturing, currently has limited applicability because the Monterey Formation reservoirs that are producing in the basin are already naturally fractured. Onshore, WST (i.e., hydraulic fracturing) of the vast areas of the Monterey Formation has had only marginal success. In fact, hydraulic fracturing of the Monterey has been attempted in some of the Monterey Fields, including the Santa Clara Field from Platform Grace in the early 1980s and more recently the Sockeye Field from Platform Gail in 2010. The stimulation was not deemed economically successful. Only four of the six stages achieved injection, and although total fluid recovery increased, this was primarily due to an increase in produced water rather than an increase in oil recovery. Pacific OCS operators that produce from the Monterey were informally polled in 2013 regarding future plans to use hydraulic fracturing in the Monterey Formation. Although none would rule it out completely, they all stated that they had no future plans to do so (Mayerson 2015).

A hydraulic fracture program was undertaken by one Pacific OCS operator in 2014. Completions in two vertically drilled wells, each using 60,000 gal (1,429 bbl) of injection fluid, were fractured in the indurated Repetto sandstone of the Santa Clara field and achieved some promising initial results. According to the operator, wing lengths of the fractures were planned to be small, on the order of 100 to 200 ft in length. The operator has not submitted subsequent APMs to hydraulically fracture additional wells, but the potential for additional fracture applications exists.

A small number of wells in the Santa Barbara–Ventura Basin have had matrix acidization performed. For these activities, larger volumes of acid (e.g., approximately 10,000 gal [238 bbl]) were listed in the initial application. Based on results of matrix acidizing tests of the Monterey Formation by Plains Exploration (2003), the Monterey Formation at the Point Arguello field does not respond to acid like a carbonate reservoir. “The high siliceous content and layering interferes with the formation of worm holes and limits the treatment to the natural fractures that exist.” In short, it appears that no new permeability is created.

3.2.4 Geology of the Beta Field off of San Pedro, California

The Beta Field is located in the San Pedro Basin, part of the southernmost extension of the Los Angeles Basin. The San Pedro Basin is structurally bounded by the Palos Verdes (PVF) and Newport-Inglewood fault (NIF) systems. Both faults accommodate a significant amount of regional slip between the Los Angeles Basin and adjacent Inner Continental Borderland Tectonic provinces (Wright 1991), and they also serve as the major hydrocarbon-trapping structures within the San Pedro Basin. Structurally, the Beta Field is located on the sub-thrust section of a broad, northwest-trending anticline bounded by the Palos Verdes Fault (Figure 3-7). The

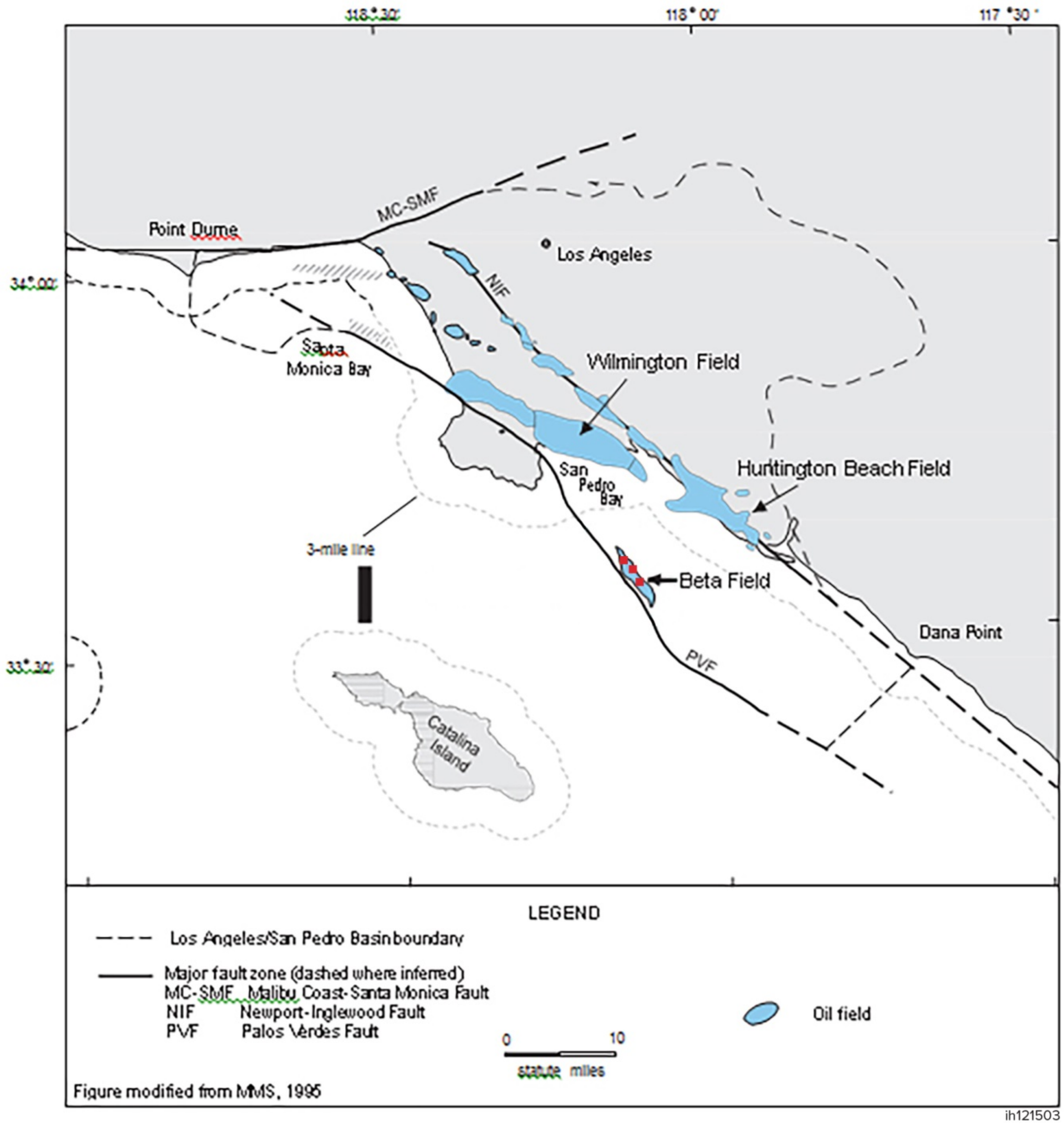

FIGURE 3-7 Location of the San Pedro Shelf and Basin (Platforms on the Southern California OCS are shown in red.) (Modified from Drewry and Victor 1997)

present-day PVF extends for approximately 66 mi southeastward from Santa Monica Bay across the northeast portion of the PVF and offshore across the San Pedro Shelf to Lasuen Knoll.

3.2.4.1 Stratigraphy

Within the Beta Field and San Pedro Basin, more than 10,000 ft of Tertiary sedimentary fill overly Cretaceous basement. Local Tertiary strata include the Miocene San Onofre Breccia, the Miocene Monterey Shale, the Miocene/Pliocene Puente Sandstone, the Pliocene Repetto Formation, the Pliocene Pico Formation, and younger Quaternary marine strata (Figure 3-8). Although the adjacent Wilmington, THUMS, Huntington Beach, and other Los Angeles Basin oil fields derive a majority of oil and gas production from the Pico, Repetto, and Monterey Formations, only the Puente Formation is productive within the Beta Field. Several wells were tested for production potential within the Monterey Formation in the Beta Field, but no meaningful oil was recovered. The lack of oil in the Monterey Formation in the Beta Field is probably a consequence of the synchronous deposition of the Monterey

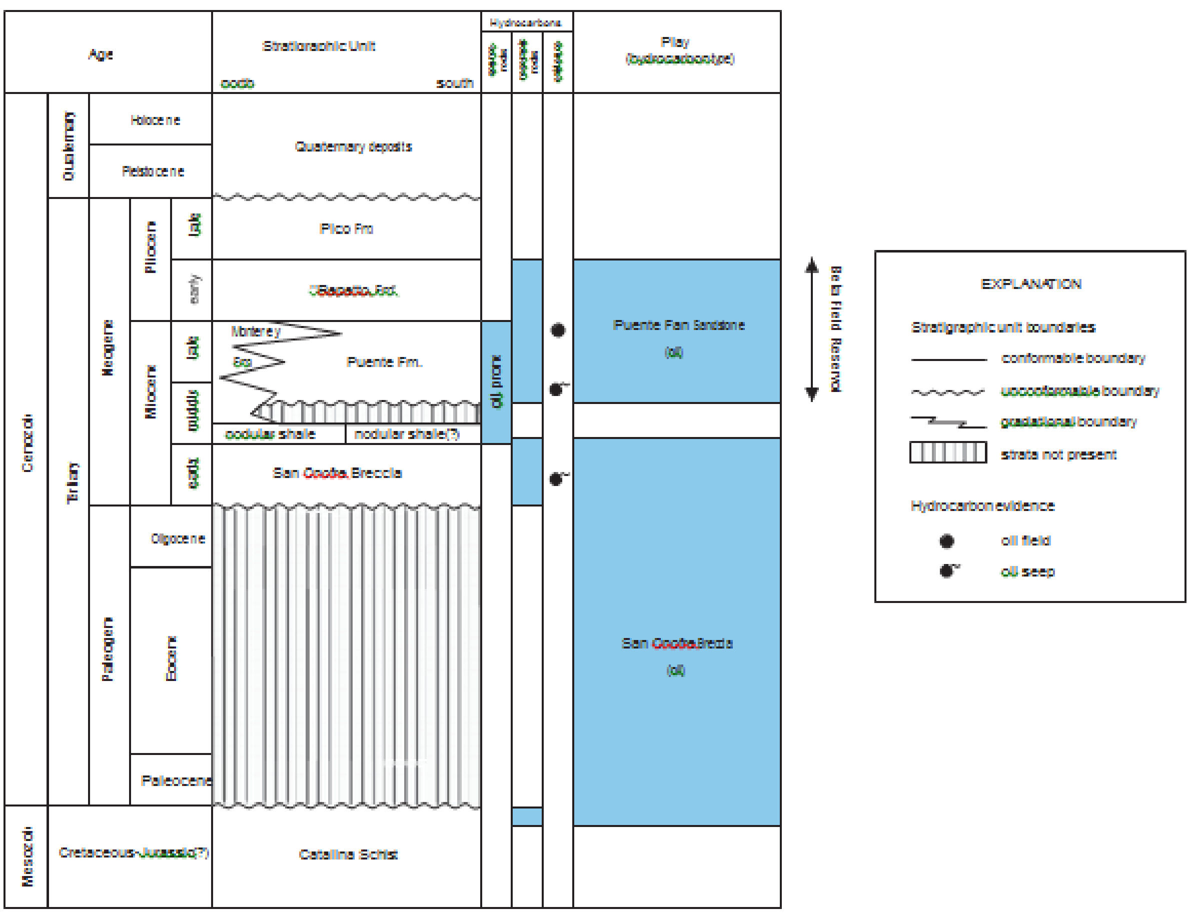

Figure modified from MMS, 1995

FIGURE 3-8 Stratigraphy of the San Pedro Shelf and Basin Region (Modified from Drewry and Victor [1995])

Formation along the southwest-dipping Miocene Palos Verdes Fault, which resulted in the majority of the Monterey Formation deposited west of the sub-thrust anticline that forms the structural trap of the Beta Field (Brankman and Shaw 2009).

The Puente Formation. The Puente Formation is a fan deposited sandstone interbedded with deep water marine shales from which the production at the Beta Field takes place. The depth to the Puente ranges from -2500 ft near the Palos Verdes Fault to about –5000 ft on the northeast flank of the Beta structure. Cumulative production through 2013 from the Beta Field is approximately 100 million bbl of oil and 32 billion ft^3 of gas. Remaining reserves for the Beta Field are estimated at 15 million bbl of oil and a little less than 5 billion ft^3 of gas.

The Monterey Formation. Below the Puente Formation is the Mohnian age equivalent of the Monterey Formation. It is a sand and shale sequence of middle Miocene age. Evaluations of the Monterey Formation in the Beta area for potential development have not obtained positive results.

3.2.4.2 Potential for Application of WST

The total volume of undiscovered, technically recoverable resources in the offshore Inner Borderland province (including the Los Angeles Basin, the Santa Monica Basin, and the San Pedro Shelf and Basin) is estimated to be 0.89 Bbbl of oil and 1.03 Tcf of associated gas (BOEM 2014; Long et al. 2015). Most of these resources are expected to be found in highly permeable sandstone reservoirs (BOEM 2014). The development of these resources, therefore, would not require the application of WST. Although low-permeability reservoirs occur offshore, it is unlikely that large-scale program involving hydraulic fracturing technology would be employed because of logistical issues (Long et al. 2015).

3.2.5 Seismicity

The ridges and basins of the California Continental Borderland are bounded by several major active faults that are capable of producing damaging earthquakes (and tsunamis) in close proximity to metropolitan areas of southern California (Given et al. 2015). Figure 3-9 shows the Quaternary faults[4] of the onshore and offshore California borderland. The major, best-known fault in the region is the San Andreas Fault.

Earthquake activity in the region is monitored by the Southern California Seismic Network (SCSN), an automated seismic network managed by the U.S. Geological Survey (USGS) in cooperation with the California Institute of Technology. Figure 3-10 is a seismicity map of the offshore California borderland showing earthquake events between 1932 and

[4] Quaternary faults are faults that have been observed at the surface and for which there is evidence of movement in the past 1.6 million years, the duration of the Quaternary Period.

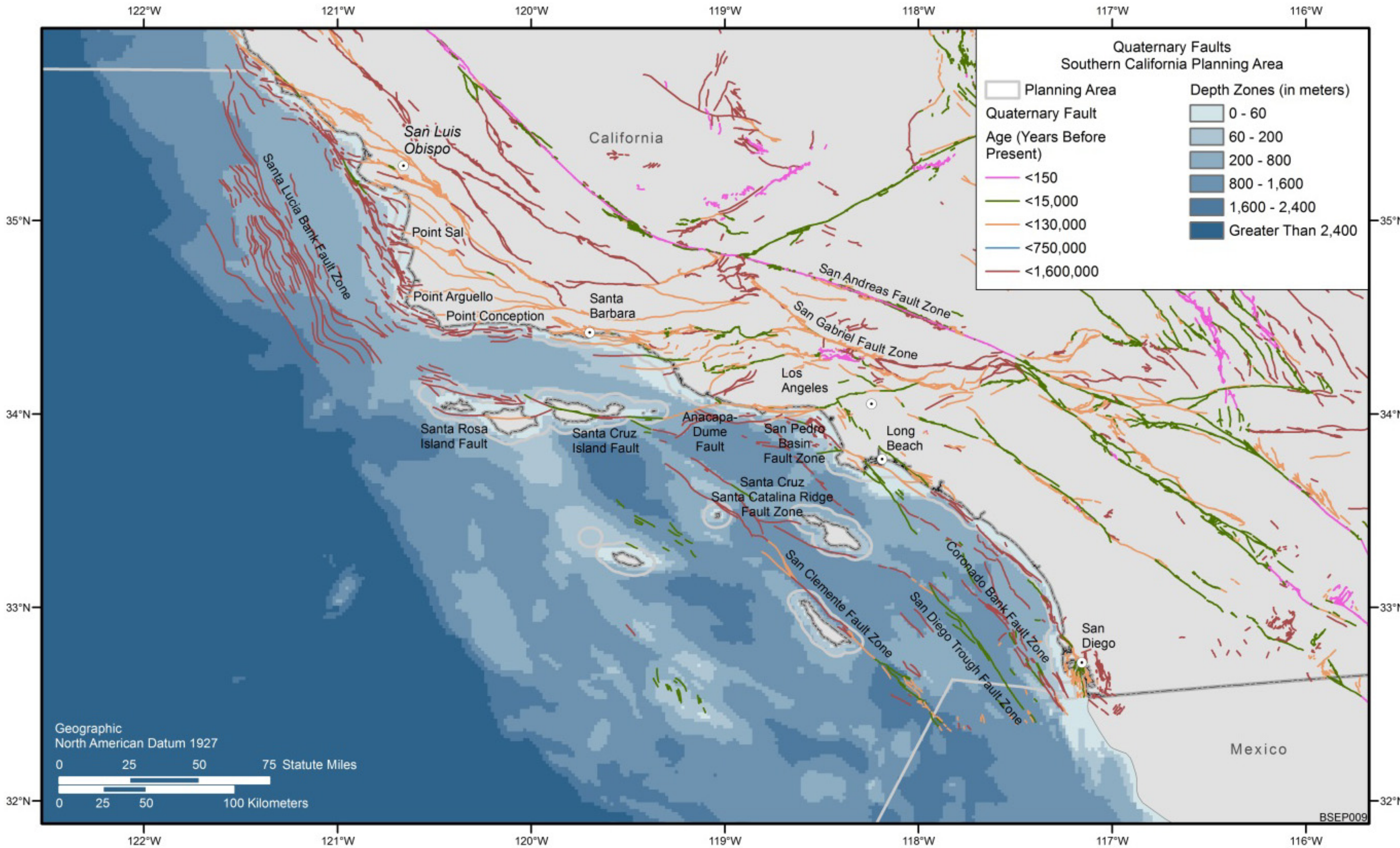

FIGURE 3-9 Quaternary Faults in the California Borderland Region (Data source: USGS 2015a)

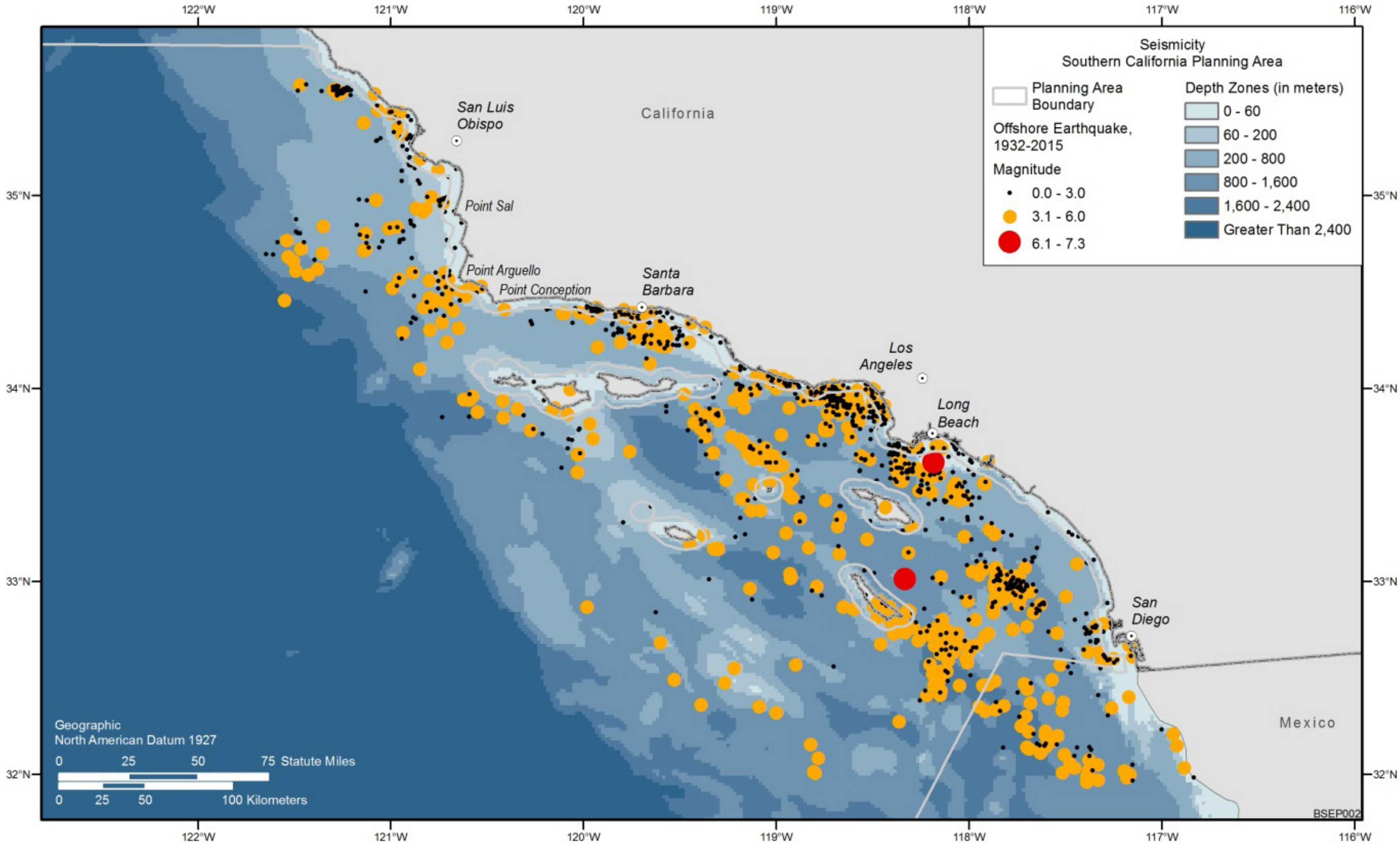

FIGURE 3-10 Seismicity of the Offshore California Borderland Region (Data source: USGS 2015c)

May 2015 in three magnitude (moment magnitude or Richter scale) categories: (1) 0 to 3; (2) 3.1 to 6.0; and (3) 6.1 to 7.3. Most of the earthquakes are of relatively small magnitude, in the 0 to 3 range. However, several significant earthquakes (Richter magnitude of 6 or greater or Modified Mercali intensity scale VIII or greater) have occurred in historic times on the San Pedro Shelf just offshore of Long Beach, to the southeast of the Santa Barbara Channel. The last significant onshore earthquake in the Santa Barbara and Ventura county area occurred in 1857. This quake, known as the “Fort Tejon” quake, has been estimated to have had a magnitude at 7.9 on the Richter scale (USGS 2015b). The earthquake epicenters shown on Figure 3-10 generally follow a northwest–southeast trend because they occur along the many transform faults in the offshore and nearshore areas.

3.3 AIR QUALITY AND METEOROLOGY

Meteorological conditions, as well as current air quality conditions, are important in evaluating the potential effects of air emissions that may occur under the proposed action. In addition, there are a number of Federal and State air quality regulations and requirements that target air quality. This section describes the meteorological conditions and air quality for the four coastal counties in southern California (Santa Barbara, Ventura, Los Angeles, and Orange Counties) that border the project area for the proposed action, and the regulatory arena that would apply to the proposed action. Note that Orange County, which has no offshore facilities, is included in this analysis, because the County may be affected by OCS activities due to its downwind proximity.

3.3.1 Meteorology

Several climatic factors affect air quality on the Southern California OCS Planning Area and adjacent shoreline areas encompassing the project area. The following subsections describe these factors.

3.3.1.1 Climate

A dominating factor in the weather of California is the semi-permanent high-pressure area (so-called Pacific high) of the North Pacific Ocean, which plays an important role in seasonal climatic variations (WRCC 2015a). This pressure center moves northward in the summer, holding storm tracks well to the north, and as a result, California receives little or no precipitation from this source during that period. In the winter, the Pacific high retreats southward permitting storm centers to swing into and across California. These storms bring widespread, moderate precipitation to the State.

During the summer, the California Current of the Pacific Ocean moves southward along the California coastline bringing in cool waters of arctic origin. Extensive upwelling of colder sub-surface waters adds further cooling. Chilling of air from cool coastal water causes frequent occurrences of fog and low clouds. In addition, the cool California coastal waters hinder the development of tropical cyclones in the region.

Associated with the Pacific high, California generally experiences hot, dry summers and mild, wet winters. However, along the western side of the Coastal Range, including the project area, the climate is dominated by the Pacific Ocean, characterized by warm winters, cool summers, small daily and seasonal temperature ranges, and high relative humidity (WRCC 2015a). With increasing distance from the ocean, the maritime influence decreases.

Around the Channel Islands, the Catalina eddy can bring cooler weather, fog, and better air quality into Southern California by pushing the marine boundary layer further inland. It can stretch across up to 120 mi, last up to a few days, and is most common between April and October, peaking in June (NASA 2015). Several times per year during the non-summer season, a high pressure area centered on the Great Basin periodically produces strong and extremely dry downslope Santa Ana winds over southern California (WRCC 2015a).

3.3.1.2 Wind

California lies within the zone of prevailing westerlies, with winds primarily from the west or northwest during most of the year (WRCC 2015a; NCDC 2015a). On the open waters off southern California, the most frequent wind direction is from the west in the Santa Barbara and Santa Monica Basins, with average wind speeds ranging from 8 to 17 mph (NOAA 2015a). Wind patterns are altered depending on coastline orientation, due to local and diurnal sea/land breeze circulation. For example, southeasterly winds occur as often as westerly winds at Santa Barbara, and southerly winds as often as northwesterly winds at Long Beach. Wind speeds at land stations along the coastline range from 4 to 9 mph, which is lower than those at buoy stations with lower surface friction.

3.3.1.3 Temperature

Annual average temperatures off the southern California coast have historically ranged over 56–60°F (NOAA 2015a). Due to a moderating influence of the Pacific Ocean, monthly variations in ambient temperatures are relatively small (about 6–8°F). Minimum monthly temperatures occur in February through March, ranging from 53 to 56°F, while maximum monthly temperatures occur in either September or October, ranging from 59 to 65°F.

Inland locations along the coast typically experience ambient temperatures that are lower and more moderate than those located farther inland, but slightly higher than those offshore. Annual average temperatures range from 57 to 65°F (WRCC 2015b). December and January are the coldest months, with minimum temperatures ranging from 51 to 58°F, and August is the warmest month with average maximums ranging from 63 to 74°F.

3.3.1.4 Precipitation

Annual precipitation in the project area has averaged about 17 in., ranging 11–30 in. (WRCC 2015b). On average, about 35 days a year (ranging from 27 to 46 days a year) have measurable precipitation (0.01 in. [0.025 cm] or higher). California seldom receives precipitation from Pacific storms during the summer. About 60% of the annual precipitation occurs during the winter months when the Pacific high decreases in intensity and retreats southward (WRCC 2015a). The presence of the coastal mountains contributes to rainfall in the project area. There has been negligible measurable snowfall in the area that has been recorded.

3.3.1.5 Atmospheric Stability

Atmospheric stability plays an important role in dispersing gases or particulates emitted into the atmosphere. Vertical motion and pollution dispersion are enhanced in an unstable atmosphere and are suppressed in a stable atmosphere. For southern California coastal areas, unstable conditions occur about 20% of the time, while neutral and stable conditions each occur about 40% of the time (Doty et al. 1976). In the project area, the atmosphere over the water area tends to be neutral to slightly unstable.

3.3.1.6 Mixing Height

Mixing height provides a measure of the height in the lower atmosphere through which atmospheric pollutants are dispersed. The mixing height depends on the heat flux (rate of warming of the surface layer) and wind speed. Due to steady moderating influences of the Pacific Ocean, diurnal and seasonal variations in mixing heights over water and at coastal stations in the project area are relatively small, compared to those at inland locations.

Over the water, the air-sea temperature differences change slowly with time; thus, the mixing heights are relatively constant and low, with a typical marine mixing height of about 1,640 ft over low latitude oceans (LeMone 1978). In contrast, overland there is considerable diurnal variation, with low mixing heights at night and high mixing heights associated with daytime heating. Mixing heights along the coasts of the four counties adjacent to the Southern California OCS Planning Region typically range between 1,640 and 3,280 ft, with annual average morning and afternoon mixing heights of 1,800 and 2,790 ft, respectively (Holzworth 1972).

3.3.1.7 Severe Weather

Severe weather events have been reported in the National Climatic Data Center (NCDC) *Storm Events Database* (NCDC 2015b) for the four coastal counties adjacent to the project area. High or thunderstorm winds, floods, wintery weather, high surf, and wildfires are frequently reported but tornadoes, hail, and tropical storms are reported only on occasion. Except for wildfires and tropical storms, these events occurred in any month of the year but occurred more frequently in colder months, when the Pacific high decreases in intensity and migrates to the south.

Hurricanes and tropical storms formed off the coast of Central America and Mexico dissipate and rarely hit California due to the cold-water current off the California coast, which weakens storms from the south. In addition, the general trend in hurricane motion is to the west-northwest due to the prevailing winds (NOAA 2015b) which takes hurricanes away from the California coast. Historically, only four tropical depressions passed within a 100-mi radius of the project area and no hurricanes or tropical storms have hit north of central California.

3.3.2 Air Quality

3.3.2.1 Ambient Air Quality Standards

Under the Clean Air Act (CAA), the U.S. Environmental Protection Agency (EPA) has established the National Ambient Air Quality Standards (NAAQS) for pollutants considered harmful to public health and the environment (40 CFR 50). The EPA has set NAAQS for six principal pollutants (known as "criteria" pollutants): ozone (O_3), particulate matter (PM) with an aerodynamic diameter of 10 microns (μm) or less and 2.5 μm or less (PM_{10} and $PM_{2.5}$, respectively), carbon monoxide (CO), nitrogen dioxide (NO_2), sulfur dioxide (SO_2), and lead (Pb) (EPA 2015a). Collectively, the levels of these criteria pollutants are indicators of the overall quality of the ambient air.

The CAA established two types of NAAQS: primary standards (also referred to as "health effects standards") to provide public health protection, including protecting the health of sensitive populations such as asthmatics, children, and the elderly; and secondary standards (referred to as the "quality of life standards") to provide public welfare protection, including protection against decreased visibility and damage to animals, crops, vegetation, and buildings. Many of the NAAQS standards address both short- and long-term exposures (e.g., 1 hr, 8 hr, 24 hr, 30 day, and annual).

The Air Resources Board (ARB), the clean air agency of the State of California, has established separate ambient air quality standards (California Ambient Air Quality Standards, CAAQS) to protect human health, safety, and welfare (ARB 2015a). The CAAQS include the same six criteria pollutants as in the NAAQS, but in contrast with the NAAQS they also include standards for visibility reducing particles, sulfates, hydrogen sulfide, and vinyl chloride. In general, the CAAQS are more stringent than the NAAQS, except for 1-hr NO_2 and SO_2 standards that were established in 2010. Table 3-3 presents the current CAAQS and NAAQS.

3.3.2.2 Area Designations

The EPA assigns area designations based on how the air quality of an area compares to the NAAQS. Areas with air quality that is as good as or better than NAAQS are designated as

TABLE 3-3 California Ambient Air Quality Standards and National Ambient Air Quality Standards

			NAAQS[b]	
Pollutant	Averaging Time	CAAQS[a]	Primary[c]	Secondary[d]
Ozone (O_3)	1 hour	0.09 ppm (180 $\mu g/m^3$)	—[e]	—
	8 hour	0.070 ppm (137 $\mu g/m^3$)	0.075 ppm	Same as Primary Standard
Respirable particulate matter (PM_{10})	24 hour	50 $\mu g/m^3$	150 $\mu g/m^3$	Same as Primary Standard
	Annual	20 $\mu g/m^3$	—	—
Fine particulate matter ($PM_{2.5}$)	24 hour	—	35 $\mu g/m^3$	Same as Primary Standard
	Annual	12 $\mu g/m^3$	12 $\mu g/m^3$	15 $\mu g/m^3$
Carbon monoxide (CO)	1 hour	20 ppm (23 mg/m^3)	35 ppm	—
	8 hour	9.0 ppm (10 mg/m^3)	9 ppm	—
	8 hour (Lake Tahoe)	6 ppm (7 mg/m^3)	—	—
Nitrogen dioxide (NO_2)	1 hour	0.18 ppm (339 $\mu g/m^3$)	100 ppb	—
	Annual	0.030 ppm (57 $\mu g/m^3$)	53 ppb	Same as Primary Standard
Sulfur dioxide (SO_2)	1 hour	0.25 ppm (655 $\mu g/m^3$)	75 ppb	—
	3 hour	—	—	0.5 ppm
	24 hour	0.04 ppm (105 $\mu g/m^3$)	—	—
Lead (Pb)	30 day	1.5 $\mu g/m^3$	—	—
	Rolling 3 month	—	0.15 $\mu g/m^3$	Same as Primary Standard
Visibility reducing particles	8 hour	See footnote f	—	—
Sulfates	24 hour	25 $\mu g/m^3$	—	—
Hydrogen sulfide	1 hour	0.03 ppm (42 $\mu g/m^3$)	—	—
Vinyl chloride	24 hour	0.01 ppm (26 $\mu g/m^3$)	—	—

[a] Detailed information on attainment determination criteria for CAAQS and reference method for monitoring is available in ARB (2015a).

[b] Detailed information on attainment determination criteria for NAAQS and reference method for monitoring is available in 40 CFR 50 and EPA (2015a).

[c] Primary standards provide public health protection, including protecting the health of “sensitive” populations such as asthmatics, children, and the elderly.

[d] Secondary standards provide public welfare protection, including protection against decreased visibility and damage to animals, crops, vegetation, and buildings.

[e] Not applicable.

[f] In 1989, the ARB converted both the general Statewide 10-mi visibility standard and the Lake Tahoe 30-mi visibility standard to instrumental equivalents, which are “extinction of 0.23 per kilometer” and “extinction of 0.07 per kilometer” for the Statewide and Lake Tahoe Air Basin standards, respectively.

Sources: ARB (2015a); EPA (2015a).

"attainment areas" while areas in which air quality is worse than NAAQS are designated as "nonattainment areas." Areas that previously were nonattainment areas but where air quality has improved to meet the NAAQS are redesignated "maintenance areas," and any area that cannot be classified on the basis of available information as meeting or not meeting the NAAQS for any pollutant is defined as an "unclassified area." These area designations impose Federal regulations on pollutant emissions and a time period in which the area must again attain the standard, depending on the severity of the regional air quality problem. The ARB similarly designates areas, but on the basis of the CAAQS.

Based on the most recent available monitoring data, a summary of the attainment status for the six criteria pollutants in Santa Barbara, Ventura, Los Angeles, and Orange counties is presented in Table 3-4. All four counties are designated as either attainment or unclassified areas for all NAAQS criteria pollutants except Los Angeles and Orange Counties, which are nonattainment areas for both O_3 and $PM_{2.5}$. Ventura County is a nonattainment area for O_3, and part of Los Angeles County is a nonattainment area for lead. Based on the CAAQS, all four counties are designated as nonattainment areas for O_3 and PM_{10}, and Los Angeles and Orange Counties are nonattainment areas for $PM_{2.5}$ (ARB 2015b). All four counties are in attainment for other the CAAQS criteria pollutants.

TABLE 3-4 Summary of State and Federal Attainment Designation Status[a] for Criteria Pollutants in Santa Barbara, Ventura, Los Angeles, and Orange Counties

	O_3		PM_{10}		$PM_{2.5}$		CO		NO_2		SO_2		Pb	
County	State	Fed.	State	Fed.	State	Fed.	State	Fed.	State	Fed.	State	Fed.	State	Fed.
Santa Barbara	N	A/U	N	U	U	A/U	A	A/U	A	A/U	A	U	A	A/U
Ventura	N	N	N	U	A	A/U	A	A/U	A	A/U	A	A	A	A/U
Los Angeles	N	N	N	A/U	NP	NP	A	A/U	A	A/U	A	A/U	A	NP
Orange	N	N	N	A	N	N	A	A/U	A	A/U	A	A	A	A/U

[a] A = attainment; N = nonattainment; NP = nonattainment in part of the county; and U = unclassified. Nonattainment is highlighted in gray.

Sources: ARB (2015b); EPA (2015b).

3.3.2.3 Prevention of Significant Deterioration

The prevention of significant deterioration (PSD) regulations (see 40 CFR 52.21), which are designed to limit the growth of air pollution in attainment areas, apply to a major new source or modification of an existing major source within an attainment area or an unclassified area. While the NAAQS (and CAAQS) place upper limits on the levels of air pollution, PSD limits the total increase in ambient pollution levels above the established baseline levels for SO_2, NO_2, PM_{10}, and $PM_{2.5}$ to prevent "polluting up to the standard." The allowable increase is smallest in Class I areas, such as national parks (NPs) and wilderness areas (WAs). The rest of the country is subject to larger Class II increments. States can choose a less stringent set of Class III increments, although currently no State has done so.

Major (large) new and modified stationary sources must meet the requirements for the areas in which they are located and the areas they impact. For example, a source located in a Class II area in close proximity to a Class I area would need to meet the more stringent Class I increment in the Class I area and meet the Class II increment elsewhere, in addition to any other applicable requirements. Aside from capping increases in criteria pollutant concentrations below the levels set by the NAAQS, the PSD program mandates stringent control technology requirements for new and modified major sources. The CAA requires Federal land managers to evaluate whether the proposed project will have an adverse impact on air quality-related values in Class I areas, including visibility. As a matter of policy, the EPA recommends that permitting authorities notify Federal land managers when a proposed PSD source would locate within 62 mi (100 km) of a sensitive Class I area. There are several Federal Class I areas in California within 62 mi of the Southern California OCS Planning Area, including the San Rafael Wilderness Area, the San Gabriel Wilderness Area, and the Cucamonga Wilderness Area.

3.3.2.4 Air Emissions

The estimated annual-average emissions of criteria pollutants and reactive organic gases (ROG) in each of the four coastal counties along the Southern California OCS Planning Area are presented in Table 3-5 (ARB 2015c).

The total emissions for Los Angeles County, the most populous county in California, account for about two-thirds of the total annual emissions of all criteria pollutants and ROG (which play a major role in the creation of photochemical oxidants in the atmosphere) for the four counties, except for SO_X. About half of the four-county total for SO_X comes from Los Angeles County. Orange County accounts for about 15–21% of the four-county total for all pollutants, except that it only accounts for about 5% of SO_X. Santa Barbara and Ventura Counties are similar, accounting for no more than 15% for any of the criteria pollutants and ROG, except for SO_X. Santa Barbara County accounts for about 40% of the four-county total of SO_X (Table 3-5). The high annual average SO_X emissions in Santa Barbara County are associated with the large number of ocean-going vessels burning fuel oil with a high sulfur content visiting its ports.

TABLE 3-5 2012 Estimated Annual-Average Emissions of Criteria Pollutants and Reactive Organic Gases, by County and by Source Category (tons per day)

	ROG	CO	NO_x	SO_x	PM_{10}	$PM_{2.5}$
By county						
Santa Barbara	29.40	123.46	83.35	13.15	15.38	5.84
Ventura	33.94	144.09	47.20	1.83	16.56	6.00
Los Angeles	287.33	1,406.56	355.07	16.22	101.29	44.64
Orange	93.69	446.31	84.39	1.67	24.29	11.25
Four county total	**444.36**	**2,120.42**	**570.01**	**32.87**	**157.52**	**67.73**
By source category						
Fuel Combustion	8.59	51.83	49.01	7.12	6.33	5.41
Waste Disposal	5.35	1.30	2.07	0.52	0.39	0.23
Cleaning & Surface Coatings	40.98	0.35	0.13	0.01	1.89	1.82
Petroleum Production & Marketing	42.37	4.91	1.51	2.26	1.67	1.44
Industrial Processes	8.17	1.37	0.58	0.75	16.73	5.72
Solvent Evaporation	103.90	0.00	0.00	0.00	0.01	0.01
Miscellaneous Processes	13.53	83.78	19.94	0.71	94.29	29.61
On-road Motor Vehicles	120.46	1,242.34	265.67	1.79	23.96	12.39
Other Mobile Sources	101.01	734.54	231.10	19.71	12.25	11.10
Four county total	**444.36**	**2,120.42**	**570.01**	**32.87**	**157.52**	**67.73**

Source: ARB (2015c).

Emissions from on-road motor vehicles and other mobile sources (including off-road equipment and vehicles, aircraft, train, boats and vessels) are the largest and second-largest contributors, respectively, to four-county total emissions of ROG, CO, and NO_x. Emissions from miscellaneous processes (including residential fuel combustion, cooking, construction/demolition, road and wind-blown dusts, etc.) and on-road motor vehicles are the largest and second-largest contributors, respectively, to both PM_{10} and $PM_{2.5}$. Other mobile sources account for about 60% of the SO_x emissions' total, followed by fuel combustion (about 22%). On-road motor vehicles and solvent evaporation are the largest and second-largest contributors, respectively, to total ROG emissions.

Natural emission sources include biogenic emissions from plants and trees, geogenic emissions from marine seeps on the continental shelf, wildfires, and windblown dust. In Santa Barbara and Ventura Counties, natural emissions are comparable to or higher than man-made emissions for ROG or PM (ARB 2015c). Emissions of ROG from marine seeps can be a significant source of ROG, which is a precursor to smog-forming ozone (Hornafius et al. 1999). In contrast to ubiquitous biogenic or wildfire emissions, geogenic emissions in this region are largely limited to Santa Barbara and Ventura Counties, where they are as much as 60% and 11%, respectively, of average annual man-made ROG emissions totals for these counties.

In general, greenhouse gas (GHG) emissions data are not available at the county level. In California, the total Statewide gross[5] GHG emissions in 2012 (the most recent information available) were estimated to be about 459 million metric tons (MMT) carbon dioxide equivalent (CO_2e)[6] (ARB 2015d), which was about 7.0% of the total GHG emissions in 2012 for the United States (EPA 2015c). About 85% of the California total GHG emissions are CO_2, followed by CH_4 (8%), high-global warming potential GHG[7] (4%), and N_2O (3%). By sector, transportation is the single largest source of GHG emissions (about 37%) in California, followed by industrial sources (22%) and electricity production (21%).

3.3.2.5 Regulatory Controls on OCS Activities That Affect Air Quality

The EPA has authority for Clean Air Act (CAA) compliance of air quality on the Pacific OCS as granted under Section 328 of the 1990 CAA Amendments (CAAA). On September 4, 1992, the EPA Administrator promulgated requirements (40 CFR Part 55) to control air pollution from Pacific OCS sources to attain and maintain Federal and State air quality standards and to comply with CAAA provisions for the Prevention of Significant Deterioration.

EPA delegated control of offshore facilities to the local air districts under their individual regulatory programs as if the facility were located onshore. Within this planning area, oil and gas platforms in the project area are assigned to air districts of the corresponding onshore area (COA). The 15 structures offshore of Santa Barbara County are assigned to the Santa Barbara County Air Pollution Control District (SBCAPCD). The four structures offshore of Ventura County are assigned to the Ventura County Air Pollution Control District (VCAPCD). The remaining four structures offshore Long Beach, near the boundary of Los Angeles County and Orange County, are assigned to the South Coast Air Quality Management District (SCAQMD).

Congress established a program under Title V of the 1990 CAAA to help find a solution to reduce air pollution. A Title V Operating Permit, which applies to stationary sources with air emissions over major source thresholds of air emissions (e.g., 100 tons per year), consolidates all applicable air quality regulatory requirements into a single, legally enforceable document. These permits are designed to improve compliance by clarifying what air quality regulations apply to a facility. Currently, 18 platforms on Federal waters have Title V Operating Permits, and five platforms, including Habitat off Santa Barbara County and four platforms off Long Beach (Edith, Ellen, Elly, and Eureka), have local (non-Title V) permits.

SBCAPCD, VCAPCD, and SCAQMD regulate emissions from offshore platforms, with Permits to Operate that define permitted emissions from specified equipment and service vessels.

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5 Excluding GHG emissions removed due to forestry and other land uses.

6 A measure to compare the emissions from various GHGs on the basis of the global warming potential (GWP), defined as the ratio of heat trapped by one unit mass of the GHG to that of one unit mass of CO_2 over a specific time period. For example, GWP is 21 for CH_4, 310 for N_2O, and 23,900 for SF_6. Accordingly, CO_{2e} emissions are estimated by multiplying the mass of a gas by the GWP.

7 Fluorinated GHGs, including sulfur hexafluoride (SF_6), nitrogen trifluoride (NF_3), perfluorocarbons (PFCs), and hydrofluorocarbons (HFCs).

Primary air emissions from WSTs include engine exhaust from diesel frack engines and VOCs from flowback water. Diesel particulate matter (DPM) has been designated a carcinogen in the State of California. Frack engines are currently regulated by the ARB "Airborne Toxic Control Measure (ATCM) for Diesel Particulate Matter from Portable Engines Rated at 50 Horsepower and Greater" (17 *California Code of Regulations* [CCR] § 93116). In addition, VCAPCD regulations prohibit open sumps, pits, and ponds. In Ventura County, all crude oil and produced water must be contained in closed-top tanks equipped with vapor recovery. Thus, no new permit or modification to an existing permit related to WST use is required because regulations for WST activities are already in place (Zozula 2015).

3.4 WATER QUALITY

The project area for the proposed action occurs within the Southern California Bight (SCB), which encompasses marine waters from Point Conception at the northwest end of the Santa Barbara Channel to a point just south of the U.S.–Mexico border (see Figure 3-1). This section describes the water quality and pollution sources in the project area, the 43 lease areas where WST activities may be carried out, and the water quality–related regulatory framework and requirements that would apply to the proposed action.

3.4.1 Regulatory Framework

Water resources in the United States are protected under the Federal Water Pollution Control Act of 1972, which was reauthorized as the Clean Water Act (CWA) in 1977, 1981, 1987, and 2000 (MMS 2005). Under Section 402 of the CWA, the U.S. Environmental Protection Agency (EPA) is authorized to issue National Pollutant Discharge Elimination System (NPDES) permits to regulate the discharges of pollutants to waters of the United States, the territorial sea, contiguous zone, and ocean. Implementation of the NPDES has resulted in greatly reduced pollution discharges into U.S. waters, including the study area. Discharges are regulated to maintain levels that will not cause exceedance of water quality criteria established under the CWA (EPA 1976) as updated in 2003 (FR 68, No. 250, 75507–75515), based on revised EPA guidance (EPA 2002).

Discharges from offshore O&G exploration, development, and production facilities in Federal waters off the southern California coast are currently regulated under NPDES General Permit No. CAG 280000 issued by EPA Region 9, effective on March 1, 2014, and expiring on February 28, 2019 (EPA 2013a). The EPA uses general permits to streamline the permitting process for facilities that are anticipated to discharge within the limits of the permit and thereby would not significantly affect marine environments.

The general permit issued by EPA regulates 22 identified discharges from O&G facilities, including those of well treatment, completion, and workover fluids, and covers effluents that are relevant to this EA. The general permit sets forth effluent limitations and monitoring and reporting requirements, including pollutant monitoring and toxicity testing of effluents. The point of compliance for effluents is the edge of the mixing zone, which extends laterally 100 m in all directions from the discharge point and vertically from the ocean surface to the seabed. The permit covers development and production facilities at Platforms A, B, C, Edith, Ellen, Elly, Eureka, Gail, Gilda, Gina, Grace, Habitat, Harmony, Harvest, Henry, Heritage, Hermosa, Hillhouse, Hidalgo, Hogan, Hondo, Houchin, and Irene. The permit also covers exploration facilities discharging in the permit area.

A December 2012 draft general permit was reviewed by EPA Region 9 and the California Coastal Commission (CCC) for consistency with the California Coastal Management Plan pursuant to the requirements of the Coastal Zone Management Act. In the final permit, EPA Region 9 renewed its commitment to independent monitoring with BSEE of discharges and to independently evaluate compliance with the limits specified in the general permit (EPA 2013b).

The State of California regulates ocean discharges into State waters, which extend to 3 mi from the coast, via a comprehensive water pollution control plan first issued in 1972 known as the California Ocean Plan (California EPA 2012). This plan includes effluent limitations for 84 pollutants, which apply to any facility which discharges into State waters (Aspen Environmental Group 2005). Oil platforms in State waters, it should be noted, do not discharge into the ocean.

With respect to oil spill prevention and response planning, in 1991 Executive Order 12777, which implements provisions of the Oil Pollution Act of 1990, removed offshore facilities from jurisdiction under EPA and placed them under the jurisdiction of the Department of Interior, BSEE. Offshore operators are required to submit Oil Spill Response Plans to BSEE for review in accordance with 30 CFR 254 (EPA 2013b).

3.4.2 Physical Oceanography and Regional Water Quality

The circulation of the SCB is dominated by the Eastern Boundary Current of the North Pacific Gyre system, namely the California Current (Figure 3-11). The cold, low-salinity, highly oxygenated subarctic water brought in by the California Current, flowing toward the equator with an average speed of approximately 0.25 m/s, is joined by moderate, saline, central north Pacific water flowing into the bight from the west, and warm, highly saline, low-oxygen-content water entering the bight from the south via the California Counter-Current and the California Undercurrent. The top 200 m of these waters, with subarctic origins, is typically low in salinity and high in oxygen content, with temperatures between 9 and 18°C. Waters between 200 and 500 m in depth are high in salinity and low in dissolved oxygen, reflecting their equatorial Pacific origins; this water mass has temperatures between 5 and 9°C (MMS 2001).

South of San Diego, part of the California Current turns eastward into the SCB and then poleward, forming the California Counter-Current, where it joins the deeper, inshore, California Undercurrent, which is generally confined to within 100 km of the coast. Below 200 m, the California Undercurrent brings warm, saline, low-dissolved-oxygen equatorial waters poleward into the SCB. Within the Santa Barbara Channel, the California Undercurrent shows considerable seasonal variability. At its weakest in winter and early spring, the California Undercurrent is found below 200 m depth; surface flow is typically equatorward. From late

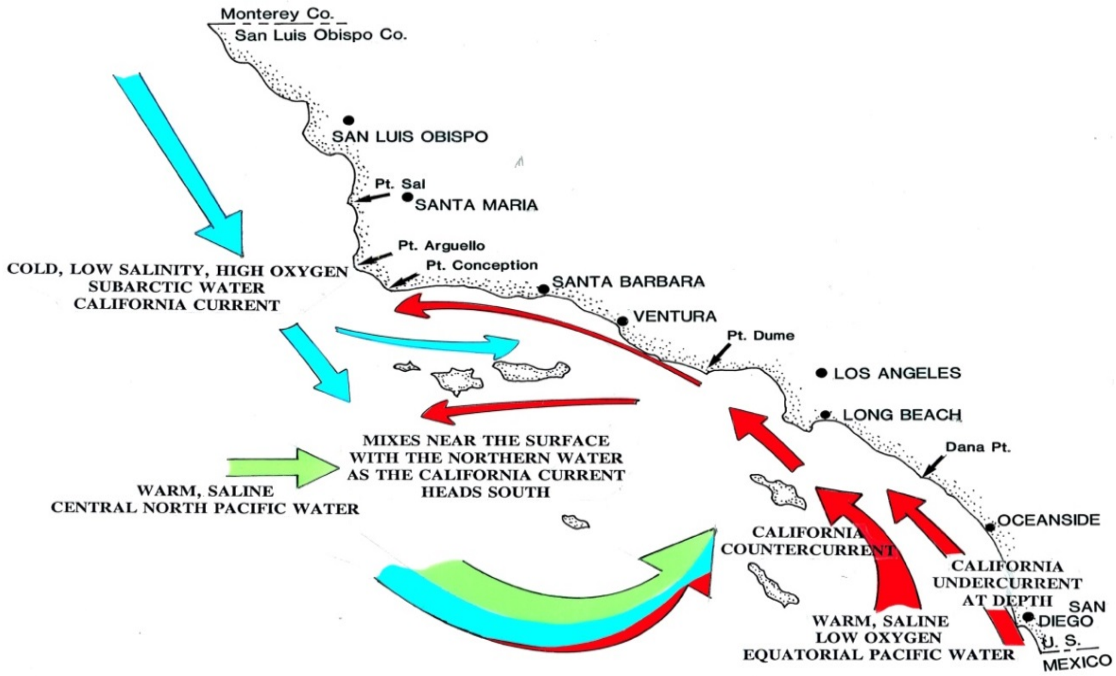

FIGURE 3-11 Characteristic Oceanic Circulation in, and Sources of Water of, the Southern California Bight (MMS 2001)

summer to early winter, poleward core flow increases and ascends to shallower depths, occasionally reaching the surface, where it joins from the inshore Countercurrent.

Winds blowing predominantly toward the southeast off the entire coast of California during the late spring to early fall move surface waters offshore. This gives rise to upwelling of cold, nutrient-rich, bottom water at the coast that, in turn, moves this water mass offshore in a continual cycle (MMS 2001).

Water quality in the SCB is generally good, particularly in the Santa Maria Basin area, and points north due to low population and lack of major industry. The Santa Barbara channel region, which extends from Point Conception to Point Fermin and includes most of the OCS oil platforms, has larger influxes of pollutants from municipal sewage treatment discharges, power plant cooling water discharges, and industrial waste sources than points further to the north. A 1994 comprehensive regional monitoring survey conducted by the SCB Pilot Project, however, found water quality to be good throughout the SCB (MMS 2001). A more recent water quality survey with the objective of determining whether anthropogenic nutrient sources were influencing algal blooms in the SCB found that at a bight-wide scale, natural nutrient sources made a much larger contribution of nutrients than anthropogenic sources. However, at smaller spatial scales, anthropogenic and natural nitrogen sources were found to be comparable within orders of magnitude. Moreover, because the coastal waters in the SCB are generally nitrogen limited, any nitrogen inputs would be likely have an impact on biological productivity (Howard et al. 2012).

Since the introduction of the NPDES program, the SCB has seen great reductions in pollutants, including 50% for suspended solids, 90% of combined trace metals, and more than 99% for chlorinated hydrocarbons. Measurements of sediments, fish, and marine mammals all show decreasing contamination. This has occurred despite great increases in population and volumes of discharged wastewater (MMS 2001). This reduction was accomplished through source control, pretreatment of industrial wastes, reclamation and treatment plant upgrades (MMS 2001). There is no reason to expect that this trend would have been reversed in the ensuing years since this 2001 report given the ongoing implementation of the NPDES program.

Regulated point sources and unregulated nonpoint sources contribute to water pollution. Major sources of pollutants are agricultural runoff, which includes pesticides and fertilizer nutrients delivered to marine waters by local rivers and storm drains, publicly owned treatment works (POTW) outfalls, chlorinated power plant cooling water, and atmospheric fallout from metropolitan areas (MMS 2001, 2005; Kaplan et al. 2010; Lyon and Stein 2010). Among these, POTWs represent the largest point source contributors to the SCB. Other important regional inputs include chemicals from harbors, dumping activities, dredging, vessel traffic, military activities, and industrial activities including oil production (Kaplan et al. 2010).

Offshore O&G operations are smaller contributors of pollution, but contribute relatively higher amounts of hydrocarbon pollutants than do the other anthropogenic sources mentioned (Lyon and Stein 2010). The largest contributors of hydrocarbons to offshore waters are the naturally occurring seeps within the Santa Barbara Channel. These seeps often produce localized, visible sheens on the water and lead to the production of tar balls commonly found on beaches after weathering and oxidation of oil (Hostettler et al. 2004; Farwell et al. 2009).

Although overall water quality has improved in recent decades as a benefit of the NPDES program, the frequency of algal blooms, particularly harmful algal blooms, has increased in the area. Algal blooms are primarily attributed to natural nutrient upwelling (Kaplan et al. 2010); however, nutrient pollution from agriculture population growth may play a contributing role on the sub-regional scale from riverine sources and effluents (Howard et al. 2012). Blooms of *Pseudo-nitzschia*, several species of diatoms that produce the neurotoxin domoic acid, are becoming more common and have been attributed to numerous strandings of marine mammals in the study area.

Beach closings due to fecal coliform outbreaks have also become more frequent in recent years, and are attributable to pollutants brought to coastal waters from stormwater runoff (MMS 2005). Oil spills from offshore O&G operations and associated onshore pipelines have occasionally polluted coastal waters.

3.4.2.1 Discharge Sources from Offshore Oil and Gas Activities

Offshore discharges from past and present O&G operations (in both State and Federal waters) include cooling water, produced water, sanitary waste, fire control system test water, well completion fluids, and miscellaneous other liquids. Of these, produced water represents by far the greatest discharge of petroleum-related chemical constituents. Well completion and treatment fluids represent the second largest (but relatively minor) source of chemical discharges to OCS waters.

Drilling Wastes. Steinberger et al. (2004) reviewed NPDES discharge monitoring reports for the 23 oil platforms currently operating in Federal waters to quantify discharges to the SCB in 1996 and 2000. For drilling operations, oil platforms were reported to have discharged 12,128 and 2,955 metric tons (mt) of mostly drill cuttings to the SCB in 1996 and 2000, respectively. Over four times more solids were discharged from platforms in 1996 than in 2000 (12,000 mt vs. 3,000 mt), while discharges of drilling muds were five times greater in 1996 than in 2000 (55 mt vs. 11 mt). These declines in the amounts of solid and drilling muds discharged are the consequence of the number of wells drilled in the respective years. In 1996, 31 new wells were drilled (spudded) at offshore oil platforms in southern California, while in 2000, only 13 new wells were spudded.

Total drilling discharges in 2005 included 7 million liters (L) of drilling fluids and 2,313 mt of cuttings; these amounts were lower than levels reported in 1996 (Steinberger et al. 2004; Lyon and Stein 2010). Current discharges would be expected to be similar to or lower than these levels, given current reduced levels of drilling and production. Almost all monitoring results for 2005 drilling discharges were in compliance with permit requirements, including all cadmium and mercury concentrations in discharged drilling fluids. All measures of discharges from Platform Hidalgo were in compliance in 2005, while three other drilling platforms had single drilling-related exceedances. Platforms Gail and Hogan each had one drilling fluids toxicity test exceedance, and Platform Heritage had one static sheen test exceedance, indicating the presence of oil in the drill cuttings.

Produced Water. Produced water is water that is brought to the surface from an oil-bearing formation during oil and gas extraction. Generally, the amount of produced water is low when production begins, but increases over time near the end of the field life. Produced water is a mixture (an emulsion) of oil, natural gas, and formation water (water naturally occurring in a formation), as well as any specialty chemicals that may have been added to the well for process purposes (e.g., biocides and corrosion inhibitors). Produced water total volume from all 23 platforms was 9.4 billion L in 2005. Total permitted platform discharges were 60 billion L, the vast majority of which was cooling water (59.5 billion L) (Lyon and Stein 2010). Annual average total produced water discharge for 2012 through 2014 was 5.2 billion L (Houseworth and Stringfellow 2015), indicating a substantial reduction from 2005. These values compare to 10.43 billion L total allowed under the NPDES permit. Constituent concentration for oil and grease, ammonia, copper, undissociated sulfides, and zinc were also generally, with a few exceptions, well below permitted levels for 2012–2014 (Houseworth and Stringfellow 2015). Production data for 2014 provided on the BSEE website for the Pacific OCS[8] indicate that 126,000,000 bbl (20 billion L) of water were produced from 400 wells for an average of 310,000 bbl (49 million L) of water produced per well. Oil production in 2014 of 18,480,000 bbl

8 See https://www.data.bsee.gov/homepg/data_center/production/PacificFreeProd.asp.

gives an average ratio of 6.8 bbl of water produced per 1 bbl of oil. Of the 126,000,000 bbl of water produced, 73,000 bbl, or 58%, of the produced water was reinjected into the formation through 133 separate injection wells. The remaining 53,000,000 bbl (8.4 billion L) was either discharged to the ocean or injected into onshore injection wells.

Produced water is primarily reinjected into producing formations at Platforms Irene, Ellen/Elly, and Gail. All remaining platforms discharge produced water into the ocean either directly or via another platform (Houseworth and Stringfellow 2015). All 23 platforms are addressed under the NPDES general permit for ocean discharges (EPA 2013a).

Produced water is typically the largest volume waste stream associated with O&G exploration and production, can exceed 10 times the volume of oil produced over the lifespan of a well, and may account for as much as 98% of extracted fluids during the later stages of production. In offshore operations, the produced water emulsion is first sent to a tank on the oil platform to separate the dissolved natural gas, which is typically used for fuel on the platform. The remaining produced water emulsion is then treated further, either on the platform or onshore, to separate the oil from the remaining water and other impurities.

Following separation of the oil from the produced water, constituents in the remaining produced water may include trace metals and dissolved hydrocarbons, including benzene, toluene, ethylbenzene, and xylene (collectively termed BTEX). Dissolved metals may include arsenic, barium, chromium, cadmium, copper, zinc, mercury, lead, and nickel. Inorganic constituents may include cyanides and sulfides (Kaplan et al. 2010). Table 3-6 lists “end of the pipe” concentrations of chemical constituents measured in produced water samples from 15 platforms discharging to the Pacific OCS, representing several years of sampling as reported in Discharge Monitoring Reports (MRS 2005). Most produced water is brine, with total dissolved solids too high for human consumption or for agricultural use.

Produced water is treated to make it suitable for discharge under the NPDES permit or for reinjection. Treatment methods include the use of heat, corrugated plate coalescers, electrostatic precipitation, bubbling, and chemical treatment. The NPDES general permit calls for a mixing zone of 100 m radius from the point of discharge. Calculated concentrations of the constituents at the edge of the mixing zone, after accounting for dilution, must meet the permit limits. All ocean discharges must meet the NPDES discharge limits, and are tracked through quarterly Discharge Monitoring Reports required by the NPDES permits (Kaplan et al. 2010).

A 2003 study of produced water discharge plumes from platforms Hogan, Harvest, Habitat, and Gina used rotamine dye to trace discharge plumes from the platforms and measure the effects of platform discharges on water quality in the immediate vicinity of the platforms (Applied Ocean Science 2004). Due to dilution, there were no differences in salinity, temperature, or turbidity between background locations and locations within 25–50 m of platforms. The study also reported no measurable impact on temperature, salinity, density, and turbidity of the receiving waters within the zone of initial dilution (i.e., within 100 m). Tracer dye was detectable out to distances of 0.4 to 1.5 km from the platforms.

TABLE 3-6 Concentrations (ug/L) of Chemical Constituents in Produced Water Samples from Platforms on the Pacific OCS

Class	Chemical	No. of Samples	No. of Detects (%)	Median Concentration[a]	95th Percentile Concentration[b]
Phenol	Phenol	405	269 (66%)	9.7	313
Phenol	2,4-Dimethylphenol	136	70 (51%)	25.1	2341
PAH	High-MW PAHs[c]	449	13 (3%)	0.10	3.2
PAH	Naphthalene	146	78 (53%)	10.5	97
Metal	Arsenic	425	28 (7%)	0.975	14.5
Metal	Cadmium	425	29 (7%)	0.091	1.13
Metal	Chromium	421	114 (27%)	0.68	13.6
Metal	Copper	429	106 (25%)	1.25	21.4
Metal	Lead	425	44 (10%)	0.463	7.6
Metal	Mercury	4210	24 (6%)	0.0058	0.0687
Metal	Nickel	419	72 (17%)	2.47	49.2
Metal	Selenium	180	6 (3%)	0.51	4.5
Metal	Silver	412	43 (10%)	0.25	6.7
Metal	Zinc	419	165 (39%)	5.9	168
BTEX	Benzene	233	193 (83%)	93.5	1,346
BTEX	Ethylbenzene	198	152 (77%)	23	271
BTEX	Toluene	199	150 (75%)	127	1,586
	Cyanide	388	27 (7%)	1.3	6.4
	Ammonia (w/o Harmony)	187	136 (73%)	9,405	85,486
	Ammonia (Harmony)	47	47 (100%)	85,831	335,277
	Undissociated Sulfide	99	82 (83%)	653	5,684

[a] The median concentration is that concentration that half of the samples exceed and the other half are below.

[b] The 95th percentile concentration is the concentration below which 95% of all the measured concentrations fall.

[c] PAHs with high molecular weights.

Source: MRS (2005).

Producing platforms that do not discharge produced water either transfer water to other platforms or to an onshore facility for treatment. Water treated on a platform may be discharged to the ocean or injected into an offshore subsurface reservoir. Water separated at an onshore facility can be disposed of onshore through injection to a subsurface reservoir, or be sent back to the offshore platform for disposal via injection or discharge to the ocean.

Other Production and Non-Production Effluents. Besides produced water, platform operations produce a variety of other liquid wastes. For example, in 1996 and 2000, the 23 offshore oil platforms in Federal waters in the SCB discharged roughly 56 billion and 48 billion L of (non-drilling) liquid effluent, respectively (Steinberger et al. 2004). Almost 90% of this discharge in each year was seawater used for various purposes on the platforms (i.e., cooling water, fire control system water), which was then discharged back to the ocean in accordance with NPDES permit requirements; only 10–12% was produced water. In 2005, discharges from 23 oil platforms in the Pacific OCS totaled 60 billion L, of which 16% was produced water (Lyon and Stein 2010). Operational discharges accounted for the remaining volume, 99% of which was cooling water. Fire control system water, sanitary and domestic wastes, deck drainage, and minor discharges contributed the remaining 1% of this volume.

Discharges from platforms have been reported to be relatively minor compared to effluents from large and small POTWs, with respect to both effluent volume and constituent mass. In addition, oil seeps may contribute almost 10 times more hydrocarbons to coastal waters than produced water discharges, while the transportation sector contributes about twice as much hydrocarbon pollution to the coastal ocean than does offshore oil and gas production (Steinberger et al. 2004). Hydrocarbon pollution from combustion sources, including the transportation sector, enters the ocean primarily in stormwater runoff during the rainy season after atmospheric deposition of particulate combustion products onto land surfaces. Stormwater discharges from rivers can sometimes create turbid plumes carrying chemical and bacterial contamination that can extend for several kilometers offshore (Kaplan et al. 2010).

Well Treatment, Workover, and Completion Fluids. Other platform discharges may include chemicals associated with well treatment, workover, and completion fluids (Kaplan et al. 2010). These chemicals can be classified into three categories:

- Production-treating chemicals: scale inhibitors, corrosion inhibitors, biocides, emulsion breakers, and water treating chemicals, including reverse emulsion breakers, coagulants, and flocculants;

- Gas-processing chemicals: hydrate inhibitors, dehydration chemicals, and occasionally H_2S removal chemicals; and

- Stimulation and workover chemicals: mineral acids, dense brines, and other additives.

After injection and use, WST fluids return to the platform at diluted concentrations as part of the produced water and crude oil streams. Oil, gas, and water are separated, and the component of WST fluids included in the produced water steam is treated and discharged along with those produced under the NPDES general permit or reinjected into the formation (Houseworth and Stringfellow 2015). WST chemicals are used intermittently and in small volumes, and following treatment are highly diluted by the much higher volumes of produced water before discharge. Such dilution often reduces final concentrations in discharge samples to levels that are difficult to measure (Kaplan et al. 2010). Accidental releases of well stimulation fluids have not been reported in spill data available through 2011 (Houseworth and Stringfellow 2015).

Hydrogen Sulfide. Hydrogen sulfide (H_2S), a toxic gas, may be produced along with oil and gas. H_2S is not an approved EPA waste that can be discharged. On some platforms, it is captured and separated via several different waste separation systems (e.g., amine or Sulfurox). The resulting waste is then taken to shore for disposal. H_2S is strictly monitored as an air pollutant due to its toxicity to humans.

Shell Mounds. Large mounds of mussel shells were found at the base of removed oil platforms in 1996, when Chevron removed oil platforms Heidi, Hilda, Hazel, and Hope in State waters near Summerland and Carpinteria. The mounds, which are approximately 200 ft wide and 20 to 30 ft tall, had accumulated as a result of periodic scrapings of the former platform legs (Kaplan et al. 2010). Cores taken from shell mound cores contained elevated concentrations of metals associated with drilling wastes (e.g., barium, chromium, lead, and zinc), and alkylated benzenes and PAH (Kaplan et al. 2010). A more recent study measured PAH in water near shell mounds associated with Platforms A and B on the Pacific OCS (Bemis et al. 2014) and detected very low levels of PAH in the parts per trillion range. Chemical characterization of the PAHs in the water samples indicated a predominance of unweathered crude, suggesting nearby petroleum seeps as the likely source of the PAH and a low likelihood of a significant contribution from shell mounds, which would appear as weathered crude because of how long the shell mounds had been on the sea floor. The study further found that PAH concentrations were more than an order of magnitude below California water quality objectives for the protection of marine biota and human health.

3.4.2.2 Other Discharge Sources

Publically Owned Treatment Works (POTWs). Treated municipal wastes from POTWs, along with regulated industrial discharges, are large contributors to hydrocarbon and metal loads in the SCB (MMS 2005). Lyon and Stein (2010) compared 2005 discharges of produced water from Pacific OCS oil platforms to POTW effluents, and reported that produced water from oil platforms accounted for only 0.5% of the combined effluent volume from both sources. General constituent and metals loads from oil platforms, likewise, were insignificant compared to discharges from POTWs. However, discharges of petroleum hydrocarbons, including benzene, toluene, ethylbenzene, and PAHs, were greater from produced water than from POTWs. Comparing the spatial distribution of the Pacific OCS platforms and POTWs of the area, of the 13 platforms that discharge produced water, three are located outside the SCB, nine are located in the northern SCB between Point Conception and Point Dume, and only one is located in the southern SCB between Point Dume and the U.S.–Mexico border (Lyon and Stein 2010). In contrast, 17 of the 23 POTWs in the region are concentrated in the southern SCB between Point Dume and the U.S.–Mexico border, where they dominate discharges to the region. Constituent loads from platforms in the northern SCB, however, were relatively greater, ranging from 15% up to 100% of the combined platform and POTW loads of most metals, organics, oil/grease, and ammonia.

Shipping. Other minor sources of chemical releases to coastal waters related to shipping include lubricating and hydraulic fluids from ocean vessel machinery. Soaps and solvents used on oceangoing vessels are typically biodegradable and pose little threat to the marine environment. Impacts from discharges of petroleum-based solvents are thought to be small. Small releases of antifouling paint, interior paint, and exterior paint from vessels comprise a very small quantity and impacts are thought to be negligible based on volume. Discharges of kitchen and septic wastes potentially containing treatment chemicals, pathogens, and nutrients most likely represent negligible to minimal impacts on water quality of the Pacific OCS (Kaplan et al. 2010).

Ocean Seeps. Natural oil seeps present in the immediate study area contribute to petroleum loads in the ocean. Approximately 50 oil seeps have been identified off the shore of southern California between Point Arguello and Huntington Beach. At least 38 of these seeps are located in the Santa Barbara Channel; they release an estimated 40–670 bbl of crude per day to the channel, with the greatest releases near the Coal Point Seep (MMS 2005). The Coal Oil Point seep field is an approximately 18 km^2 area off the shore of Goleta, California, and emits 50–170 bbl of oil and 100–130 tons of natural gas per day (Hornafius et al. 1999). Farwell et al. (2009) characterize the seeped oil as roughly 30% hydrocarbons and 70% resins plus asphaltenes, and describe an associated 90 km^2 fallout plume on the near-west seafloor estimated to contain 3.1×10^{10} g (3.1×10^4 metric tons) of petroleum in the top 5 cm of sediments.

Gale et al. (2013) compared exposures of Pacific sanddab (a flatfish) to petroleum hydrocarbons from 23 oil platforms and from natural seeps offshore Goleta, California, in the SCB. Platform sites were found to be no more polluted than the nearby natural areas, exhibiting only low concentrations of PAHs, polychlorinated biphenyls (PCBs), DDTs, and other contaminants.

Hostettler et al. (2004), in a study of tar balls commonly found along beaches of the SCB, concluded that tar balls are of natural and not anthropogenic origin, originating from source rock within the Monterey Formation via shallow offshore seeps. The authors found that the major occurrences were from offshore seepage near the west end of Santa Cruz Island.

Oil Spills. Oil spills have affected water quality of the SCB in the past, with the magnitude and duration of effects proportional to the amount of oil released. Spills of less than 50 bbl have generally minor and short-term impacts. Large spills affect large areas of coastline and can affect water quality for several months, while lingering effects can occur from leaching of oil from contaminated sediments. Thus, past effects have been dominated by a few large spills.

BOEM maintains a database of oil spills on the OCS (BOEM 2015). The database currently includes all Pacific and Gulf of Mexico OCS spills of greater than 1 bbl recorded from 1964 through 2010 and includes platform, pipeline, and vessel spills. Of the 2,833 total spills in the database, more than 91% (2,585) were less than 50 bbl (2,100 gal) in size. A total of six spills, each greater than 50 bbl and totaling 81,250 bbl, (3.4 million gal) were recorded between 1964 and 2011 on the Pacific OCS, in Federal waters (BOEM 2015). In addition, in June of

2012, approximately 36 bbl (1,512 gal) spilled from Platform Houchin into the surrounding waters (BSEE 2013).

The largest Pacific OCS spill in this period was the 1969 spill resulting from a well blowout at Platform A, which released an estimated 80,000 bbl of crude near Santa Barbara. This blowout most heavily impacted mainland beaches near Platform A and on Anacapa and Santa Cruz Islands (MMS 2005; Houseworth and Stringfellow 2015). A second, smaller 900 bbl spill occurred on the OCS from a pipeline near Platform B in December 1969 (Houseworth and Stringfellow 2015). The largest spill since 1969 was the Platform Irene pipeline spill in September 1997. A rupture in the pipeline that extends from Platform Irene to the shoreline released an estimated 162 bbl of crude oil into State waters and oiled approximately 40 mi of coastline (PXP 2012).

The most recent oil spill in the area occurred on May 19, 2015, when an onshore underground pipeline near Refugio State Beach ruptured, releasing over 2,300 bbl of oil. A portion of this oil reached the ocean via a ravine and oiled a stretch of the coast in Santa Barbara County, California (CDFW 2015).

3.5 ECOLOGICAL RESOURCES

Under the proposed action, operational discharges to the ocean from the platforms and support vessel traffic may affect ecological resources in the project area. This section describes the ecological resources in the project area that could be affected under the proposed action.

3.5.1 Benthic Resources

The 23 platforms operating on the Pacific OCS are found less than 15 mi offshore from Point Pedernales south to San Pedro Bay (Figure 3-1). Within this area, there is a major biogeographic transition zone in the vicinity of Point Conception, where the cold-temperate waters of the Oregonian Province located to the north meet with the warm-temperate waters of the Californian Province located to the south. The differences in the physical and water quality conditions between these provinces and the transition zone between them have resulted in the development of distinctive benthic communities (Seapy and Littler 1978; Blanchette and Gaines 2007).

3.5.1.1 Intertidal Benthic Habitats

The two most prominent intertidal benthic habitats within the area are rocky shorelines and sand beaches. Rocky shore habitats are more common north of Point Conception and along the Channel Islands offshore, while sandy beaches predominate south of Point Conception (MMS 2001; Golden 2013). The intertidal rocky shore is a relatively high energy habitat, particularly north of Point Conception and along the seaward face of the Channel Islands. Marine algae are typically associated with the substrate on rocky reefs, because they are unable to firmly attach to shifting sandy or muddy sediments; they include brown algae (*Egregia* spp. and *Eisenia* spp.), surfgrass (*Phyllospadix scouleri* and *P. torreyi*), and rockweed (*Silvetia compressa*) (Robles and Robb 1993; MMS 2001; Sapper and Murray 2003; Shelton 2010).

Mobile invertebrates found on intertidal rocky shorelines include grazers, filter feeders, and predators that live within the cover and protection provided by the larger attached sessile[9] plants and animals (Menge and Branch 2001; Witman and Dayton 2001). Mussels (*Mytilus californianus*) and barnacles (*Balanus glandula*) are dominant sessile intertidal invertebrates that provide structurally complex habitat along rocky shorelines. Rocky shoreline invertebrate communities exhibit distinct zonation due to a combination of physical and biological interactions (Menge and Branch 2001; Witman and Dayton 2001). Detailed descriptions of rocky benthic communities in southern California are provided in Seapy and Littler (1978), MMS (2001), and Aspen Environmental Group (2005). Rocky intertidal communities have been studied biannually since 1992; data and site descriptions can be found at pacificrockyintertidal.org. The Pacific environmental studies program has performed many other studies intertidal communities.

Intertidal sand beach habitats are much less stable than rocky intertidal shoreline habitats due to the continual shifting of sand by wind, wave, and current actions; as a result, populations of resident benthic biota may vary greatly from year to year. The invertebrates inhabiting sandy intertidal habitats are dominated by burrowing animal species, including crustaceans (isopods and amphipods), polychaete and nemertean worms, mollusks (snails and bivalves), and mole crabs (*Emerita analoga*) (MMS 1987, 2001). Detailed descriptions of sandy beach ecology and associated biotic communities in southern California may be found in Seapy and Littler (1978), MMS (2001), and Aspen Environmental Group (2005).

3.5.1.2 Subtidal Habitats

Subtidal seafloor habitats are strongly influenced by substrate type, food availability, and depth. As a result, the geology, topography, and bathymetry of an area together with oceanographic and biological processes affect the composition and abundance of marine organisms associated with seafloor habitats. Subtidal habitats in southern California are primarily soft sediments (sand and mud in areas receiving river runoff), but significant hard bottom areas are also present in the form of rocky outcrops and topographic features such as submerged reefs and seamounts (Golden 2013).

Subtidal soft sediments are dynamic habitats subject to periodic disturbance from water movement at the seafloor. Invertebrate species inhabiting soft sediments can be classified as infauna (organisms living within sediments) or epifauna (organisms living on the sediment surface). Invertebrate community structure also changes across depth from shallow inshore areas to the continental slope and abyssal plain. One of the most comprehensive studies of subtidal benthic epifauna and infauna in southern California was conducted by the Southern California Bight Regional Monitoring Program (Allen et al. 2011; Ranasinghe et al. 2012), which sampled

[9] Sessile means the organism is attached in place and immobile.

invertebrates across habitat and depth gradients that included estuaries; bays and harbors (5–30 m); inner (5–30 m), middle (31–120 m), and outer (121–200 m) continental shelf; and the continental slope (>121 m). Across habitat and depth zones, polychaete worms, amphipod crustaceans, bivalve molluscs, and brittle stars dominated the benthic infauna living in the soft sediments (Ranasinghe et al. 2012). The infaunal communities around the Channel Islands had the highest species diversity of all of the subtidal communities sampled. Infaunal diversity and abundance was relatively low in slope communities.

Trawl surveys indicated that epifaunal community structure also varied with habitat and depth. Species abundance was generally highest on the continental slope and the middle shelf near the Channel Island (Allen et al. 2011). The lowest epifaunal abundance was found in the inner continental shelf. The most abundant epifauna were echinoderms, primarily sea stars and sea urchins. A variety of crab species, including the commercially important Dungeness crab and rock crabs (*Cancer* spp.), also occur on sandy substrates (Carroll and Winn 1987).

Exposed rock and coarse grained sediments, such as gravels, generally support sessile organisms, which generally cannot attach to unstable, sandy substrate. One key rocky subtidal habitat is formed by giant kelp (*Macrocystis pyrifera*) beds, which provide important nursery habitats for a wide variety of benthic organisms (Ebeling et al. 1985; Blanchette et al. 2002). The *M. pyrifera* beds of the Channel Islands, in particular, support dense and diverse invertebrate communities of which echinoderms, polychaetes, amphipods, decapods, and gastropods are primary constituents (Graham 2004).

Topographic features can be of low (<1 m) or high (>1 m) relief, and provide structure for the development of rich benthic invertebrate communities that, in turn, support fishes and other marine organisms. Biological communities on these two feature types differ markedly because low-relief areas are subject to greater disturbance from river runoff and sediment deposition, and consequently contain less-diverse, shorter-lived communities tolerant of sedimentation (Aspen Environmental Group 2005). High-relief features are less subject to such disturbances and are characterized by less-tolerant long-lived organisms such as sponges, corals, and feather stars. The implementation of special fishery regulations or designation of such areas as habitats of particular concern is a reflection of the importance of these subtidal habitats to fish and invertebrates (see Section 3.5.2.2).

The 23 platforms in the Pacific OCS present a novel habitat when compared with the surrounding soft sediments. The platforms serve as artificial reefs, providing attachment sites for sessile reef invertebrates such as corals, bryozoans, and sponges. The fish and invertebrates associated with the platforms are structure-oriented species similar to those found in natural hard bottom habitats. Platforms in the Pacific OCS have been reported to have the highest secondary fish production per unit area of seafloor of all marine habitat that has been studied globally (Claisse et al. 2014).

3.5.1.3 Threatened and Endangered Invertebrate Species

Several species of invertebrates occurring in the coastal and marine habitats in Southern California have been listed as endangered under the Endangered Species Act of 1972 (ESA) (16 U.S.C. § 1531 et seq.). These species are the black abalone (*Haliotis cracherodii*) and the white abalone (*Haliotis sorenseni*). The Morro shoulderband snail is found only in coastal dune and scrub communities in San Louis Obispo County, California (USFWS 1998), and it is not expected to be affected by any of the alternatives.

The black abalone is a marine mollusk found in rocky intertidal and subtidal marine habitats. This species was listed as endangered on January 14, 2009 (74 FR 1937). In addition, most of the rocky subtidal and intertidal areas of the mainland California coastline south of Del Mar Landing Ecological Reserve to Government Point, the shoreline of the Channel Islands, and portions of the California coastline south of Point Conception have been listed as critical habitat for the black abalone (76 FR 66841). The black abalone population along the California coast south of Monterey County, California, has been estimated to have declined by as much as 95% (Neuman et al. 2010). Historical and/or ongoing threats include overfishing, habitat destruction, and more recently, the disease of withering syndrome.

The white abalone, another marine mollusk, was listed as endangered throughout its range along the Pacific Coast (Point Conception, California, United States, to Punta Abreojos, Baja California, Mexico) as of June 2001 (66 FR 29054). No Critical Habitat designation has been made for this species (66 FR 29046). The initial decline in white abalone abundance has been attributed to commercial overharvesting. Regulatory measures taken by the State of California during the past 30 years, including the closure of the white abalone fishery in 1996 and the closure of all abalone fisheries in central and southern California in 1997, have proven inadequate for recovery (NMFS 2008). Surveys conducted in southern California indicate that there has been a 99% reduction in white abalone abundance since the 1970s (NMFS 2008).

3.5.2 Marine and Coastal Fish and Essential Fish Habitat

The Southern California OCS supports a diverse fish community, reflecting the diverse habitats (i.e., rocky reef, sand, kelp) and the presence of cold and warm water masses divided by Point Conception (Dailey et al. 1993). Fish species found in the vicinity of the OCS platforms can be characterized as either diadromous, pelagic, or demersal, based on their habitat associations and life history traits.

3.5.2.1 Marine and Coastal Fishes

Diadromous Fish. Diadromous fish, such as salmon (*Oncorhynchus* spp.), are defined by their movement from oceanic feeding grounds to inland freshwater streams for spawning. Five species of salmon use nearshore and offshore waters, as well as spawning streams inshore of the Pacific region. The steelhead salmon (*Oncorhynchus mykiss*) is the predominant diadromous species found in southern California waters. The distribution and life history information of steelhead are detailed in NMFS (2012).

Pelagic Fishes. Pelagic species are those that do not live in or on the ocean bottom, but rather swim through the water column. Pelagic fish may occupy specific depths within the water column from the near-surface epipelagic zone to the deeper mesopelagic and bathypelagic zones. Examples of common pelagic species in southern California include northern anchovy (*Engraulis mordax*), Pacific sardine (*Sardinops sagax*), Pacific mackerel (*Scomber japonicus*), tuna (*Thunnus spp.*), Pacific herring (*Clupea pallasi*), and swordfish (*Xiphias gladius*). Many pelagic fish species are harvested by U.S. commercial and recreational fisheries (PFMC 2011b).

Demersal Fishes. Demersal fish can be generally characterized as soft bottom or hard bottom fishes, according to their association with particular substrate types. Soft bottom habitats are relatively featureless and have lower species diversity than the more structurally complex hard bottom habitats. Flatfish and rays are examples of common soft bottom species. Structure-oriented species like rockfish congregate around hard bottom habitats, including oil platforms (Claisse et al. 2014). Trawl surveys by the Southern California Bight Regional Monitoring Program (Allen et al. 2011) indicate that fish abundance decreases from Point Conception south to San Diego and that the middle and outer continental shelf have higher fish abundance than other habitats surveyed, such as bays and harbors, upper continental slope, and the inner shelf. Flatfish, sanddab, sculpin, greenling, and rockfish are abundant and widely distributed demersal fish of the California bight (Allen et al. 2011). A description of typical assemblages of demersal fish off southern California is provided in MMS (2001), Allen et al. (2011), and PFMC (2014b).

3.5.2.2 Essential Fish Habitat

The Pacific Fishery Management Council (PFMC) was established by the Magnuson Fishery Conservation and Management Act of 1976 (FCMA) (16 USC 1801–1883) to manage fisheries resources in the Pacific exclusive economic zone (EEZ). The Act requires regional fishery management councils, with assistance from the National Marine Fisheries Service (NMFS), to delineate EFH in Fishery Management Plans (FMPs) or FMP amendments for all Federally managed fisheries. An EFH is defined as the water and substrate necessary for fish spawning, breeding, feeding, and growth to maturity (50 CFR Part 600).

In addition to designating EFH, the NMFS requires fishery management councils to identify habitat areas of particular concern (HAPCs), which are discrete subsets of EFH. Councils may designate a HAPC based on (1) the importance of the ecological function provided by the habitat; (2) the extent to which the habitat is sensitive to human-induced environmental degradation; (3) whether, and to what extent, development activities are, or will be, stressing the habitat type; or (4) the rarity of the habitat type. Although a HAPC designation does not confer additional protection for or restrictions on an area, it can help prioritize conservation efforts.

The PFMC has designated EFH for four fishery management groups in the Pacific region based on their habitat associations. These include management groups are for Pacific Coast groundfish, highly migratory species, coastal pelagic species, and Pacific coast salmon (Table 3-7). The Pacific Coast Groundfish Fishery Management Plan includes flatfish, rockfish , roundfish, and sharks and rays (PFMC 2014b). The EFH included in the Pacific Coast Groundfish Fishery Management Plan covers all of the waters within the vicinity of oil platforms (Figure 3-12) and includes all waters and substrate within depths less than or equal to 3,500 m, as well as the upriver extent of saltwater intrusion, and seamounts in depths greater than 3,500 m as mapped in the EFH assessment geographic information system (GIS).

The Pacific Coast groundfish management group also identified a variety of habitats as HAPCs for groundfish, including estuaries, canopy kelp, seagrass, rocky reefs and “areas of interest,” which in southern California includes the San Juan Seamount, the Channel Islands National Marine Sanctuary, and the Cowcod Conservation Area (Table 3-8) (PFMC 2014b).

The Coastal Pelagic Species Fishery Management Plan identified EFH for six species of coastal schooling fishes, the market squid, and several invertebrate zooplankton that are key food sources for higher trophic levels (Table 3-7), and the combined EFH for these species covers the entire California EEZ (PFMC 2011a) (Figure 3-13). No HAPC have been designated for coastal pelagics (Table 3-8).

TABLE 3-7 Fishery Management Plans with Designated Essential Fish Habitat

Management Plan	Number of Species with EFH	Representative Species
Pacific Groundfish Fishery Management Plan	87	61 species of rockfish 12 species of flatfish 6 species of sharks and rays 5 species of roundfish 3 species of ratfish, morids, and grenadiers
Coastal Pelagic Species Fishery Management Plan	9+	6 fish species including sardines, anchovy, mackerel, smelt, and herring 2 squid species Several species of krill
Highly Migratory Species Fishery Management Plan	13	5 species of tuna 5 species of shark A marlin, swordfish, and dolphin
Pacific Coast Salmon Fishery Management Plan	3	3 species of salmon

Source: PFMC (2011a,b; 2014a,b)

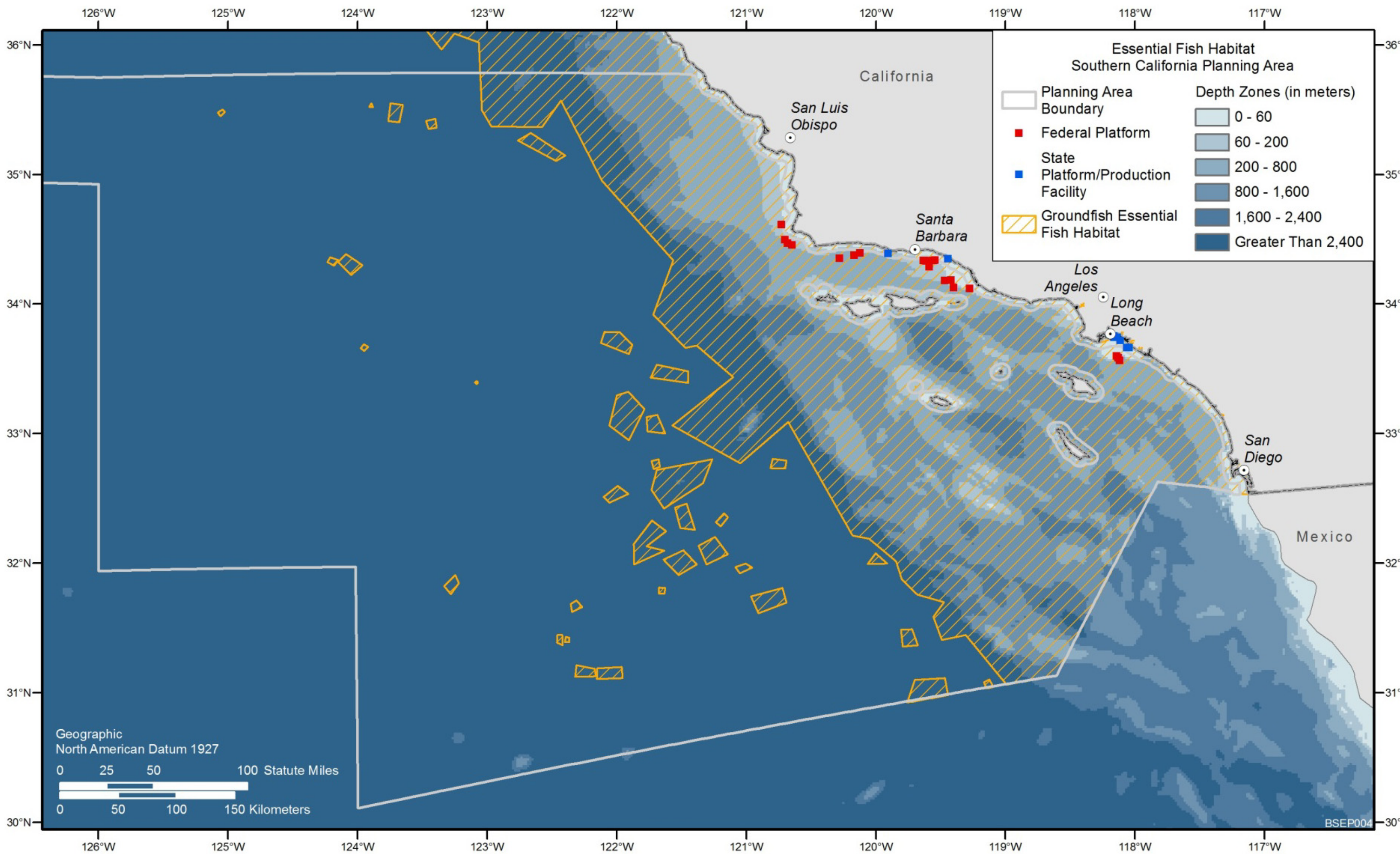

FIGURE 3-12 Groundfish EFH (including EFH-HAPC) Designated by the PFMC and NMFS (Source: NOAA undated)

TABLE 3-8 Species Management Groups and Habitat Areas of Particular Concern (HAPC) Designated by the Pacific Fisheries Management Council

Species Management Group	HAPC
Pacific Coast Groundfish	Estuaries, canopy kelp, seagrass, and rocky reef Areas of interest—San Juan Seamount; the Channel Islands National Marine Sanctuary; Cowcod Conservation Area
Pacific Coast Salmon	Complex channels and floodplain habitats Thermal refugia Spawning habitat Estuaries Marine and estuarine submerged aquatic vegetation.
Coastal Pelagic Species	There are no HAPCs designated at this time
Highly Migratory Species	There are no HAPCs designated at this time

Source: PFMC (2011a,b; 2014a,b)

Highly migratory species are defined by their pelagic habitat orientation and their geographically large movements. The Highly Migratory Species Fishery Management Plan identified EFH for several species of tuna and oceanic sharks, as well as for a swordfish, a marlin, and a sailfish. For these highly migratory species, EFH varies by species, but in total it covers all offshore waters of southern California (Figure 3-14). No HAPC has been designated for highly migratory species (PFMC 2011b) (Table 3-8).

The Pacific Coast Salmon Fishery Management Plan designates EFH for three salmonid species (Table 3-7); thee EFHs include estuarine and marine areas from the extreme high tide line in nearshore and tidal submerged environments within State territorial waters out to the full extent of the exclusive economic zone (200 nautical mi or 370.4 km) offshore of Washington, Oregon, and California north of Point Conception (PFMC 2014a). Although they have not been mapped, the PFMC also designated five HAPCs for the salmonids: (1) complex channels and floodplain habitats; (2) thermal refugia; (3) spawning habitat; (4) estuaries; and (5) marine and estuarine submerged aquatic vegetation (PFMC 2014a) (Table 3-8).

3.5.2.3 Threatened and Endangered Fish Species

Several species of fish occurring in the coastal and marine habitats in Southern California have been listed as threatened or endangered under the ESA (16 U.S.C. § 1531 et seq.). These species are the green sturgeon (*Acipenser medirostris*), the steelhead (*Oncorhynchus mykiss*), the scalloped hammerhead shark (*Sphyrna lewini*), and the tidewater goby (*Eucyclogobius newberryi*).

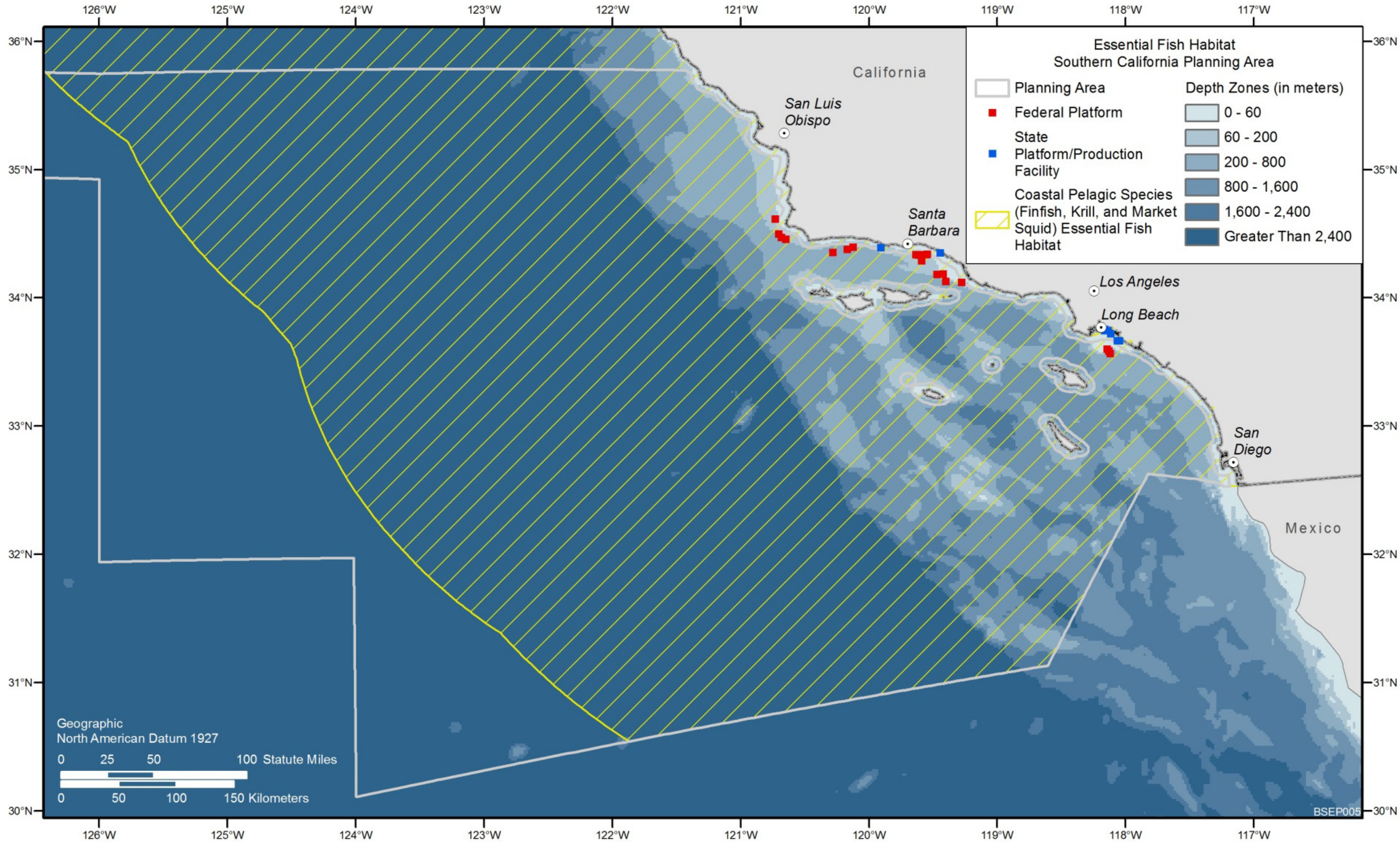

FIGURE 3-13 EFH for Coastal Pelagic Managed Species as Designated by the PFMC and NMFS (Source: NOAA undated)

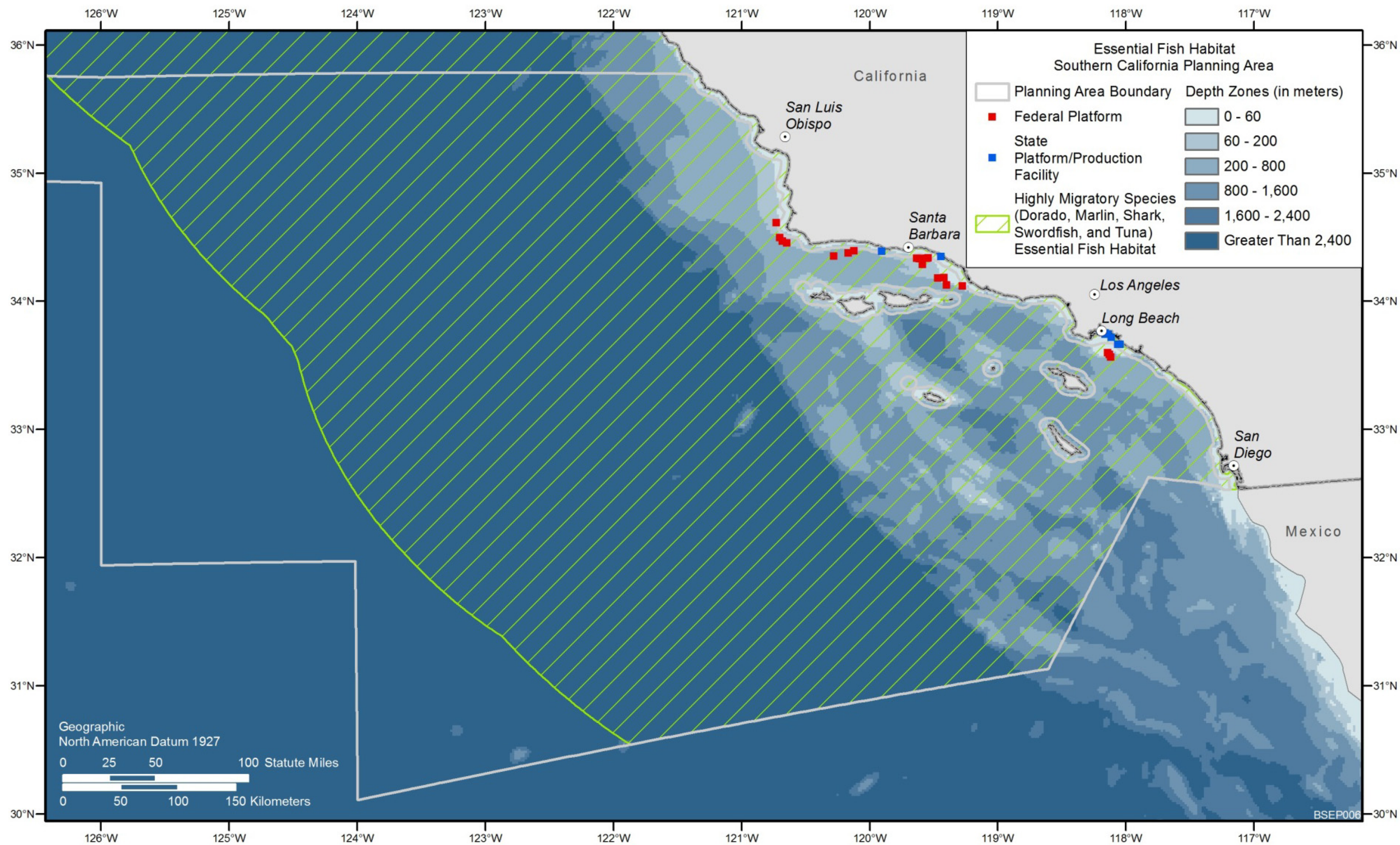

FIGURE 3-14 EFH for Highly Migratory Managed Species as Designated by the PFMC and NMFS (Source: NOAA undated)

Green Sturgeon. The green sturgeon inhabits nearshore marine waters from Mexico to the Bering Sea and enters bays and estuaries along the west coast of North America (Moyle et al. 1995). The NMFS determined that the green sturgeon is composed of southern and northern populations, with the southern population spawning primarily in the Sacramento River Basin (70 FR 17386). The southern population of green sturgeon was listed as threatened (71 CFR 17757). Although the green sturgeon was historically found along the entire coast of California, studies suggest that the southern population of green sturgeon is primarily found to the north of the Sacramento River, and the NMFS has designated no critical habitat south of Monterey Bay (74 FR 52300).

Steelhead. As diadromous fish, adult steelhead migrate to freshwater areas to spawn, and the resulting young fish travel back downstream and eventually enter marine waters to mature. NMFS has identified 10 distinct evolutionarily significant units (ESUs)[10] of steelhead, of which two are listed as endangered and eight are listed as threatened (50 CFR 223 and 224). Most of these populations are found north of Monterey Bay (Good et al. 2005) and only the Southern California Steelhead ESU (which is listed as endangered) is likely to occur in the vicinity of the OCS platforms. The geographic range of the Southern California steelhead ESU extends from the Santa Maria River basin to the U.S.–Mexico border. Major river systems with significant historical steelhead runs include the Santa Ynez, Ventura, Matilija Creek, and Santa Clara (Good et al. 2005).

The Southern California Steelhead (SCS) Recovery Planning Area includes seasonally accessible coastal watersheds and the upstream portions of watersheds that were historically used by steelhead, including in its north the Santa Maria, Santa Ynez, Ventura, and Santa Clara Rivers, and Malibu and Topanga Creeks. Major steelhead watersheds in the southern portion of the SCS Recovery Planning Area include the San Gabriel, Santa Margarita, San Luis Rey, San Dieguito, and Sweetwater Rivers, and San Juan and San Mateo Creeks (NMFS 2012). Critical habitat for the southern California steelhead includes multiple rivers between the Santa Maria River and San Mateo Creek (50 CFR Part 226).

Scalloped Hammerhead Shark. The NMFS listed the Eastern Pacific Distinct Population Segment (DPS) of scalloped hammerhead sharks as an endangered species in 2014 (50 CFR Parts 223 and 224). Critical habitat is being considered in the eastern Pacific, but no critical habitat determination has been made at this time. The scalloped hammerhead is found in coastal waters off the California coast.

Tidewater Goby. Although the tidewater goby historically occurred in at least 87 California coastal lagoons from San Diego County to Humboldt County, it has disappeared

[10] An evolutionary significant unit (ESU) is a population of organisms considered distinct for conservation purposes. To be considered an ESU, the population must be reproductively isolated from other populations of the same species, and must represent an important component of the evolutionary legacy of the species (61 FR 4722).

from most of these sites. The tidewater goby was listed as endangered in 1994 (59 FR 5494), but recently the U.S. Fish and Wildlife Service has proposed to reclassify this species as threatened (50 CFR Part 17).

The tidewater goby is found only in California, where it is restricted primarily to brackish waters of coastal wetlands, brackish shallow lagoons, and lower stream reaches larger than 2.5 ac where the water is fairly still but not stagnant (Lafferty et al. 1999). This goby is tolerant of a wide range of salinities and may be found in ocean water following flushing events that follow major rain events. As of March 8, 2013, a number of estuarine rivers and lagoons in San Luis Obispo, Santa Barbara, Ventura, Los Angeles, Orange, and San Diego Counties have been designated as Critical Habitat (50 CFR Part 17).

3.5.3 Marine Mammals

The Pacific OCS offshore of southern California has a diverse marine mammal community. Species in the orders Cetacea and Carnivora occur, at least seasonally, in southern California (Carretta et al. 2014, 2015). The Cetacea include baleen whales (Suborder Mysticeti) and toothed whales (Suborder Odontoceti). The six species of Carnivora in the area include true seals, eared seals, and a sea otter.[11]

3.5.3.1 Whales and Dolphins

Seven species of baleen whales and 12 species of toothed whales and dolphins have been reported from the South Pacific OCS Planning Area and may occur in the project area (Table 3-9).[12] Commonly observed baleen whales include the gray whale (*Eschrichtius robustus*), blue whale (*Balaenoptera musculus musculus*), fin whale (*Balaenoptera physalus physalus*), and humpback whale (*Megaptera novaeangliae*). The North Pacific minke whale (*Balaenoptera acutorostrata scammoni*) is also frequently observed in the area. The fin, humpback, and blue whales are the most commonly occurring large whales that use the area for feeding (Douglas et al. 2014). Fin and humpback whales may be observed year-round with peaks in summer and spring, respectively (Campbell et al. 2015). Blue whales are encountered in summer and fall, while minke whales are encountered in spring through fall (Douglas et al. 2014). During migration, gray whales often travel through the Channel Islands but have been observed up to 80 km offshore. Gray whales are generally present off central and southern California from December through May (Aspen Environmental Group 2005). The

11 Seals (family Phocidae) and fur seals sea lions (family Otariidae) were formerly included in the suborder Pinnipedia, but Pinnipedia is now considered a clade within the suborder Caniformia. One Steller sea lion (*Eumetopias jubatus*) was reported in the region during cruises conducted between 2004 and 2008 (Douglas et al. 2014). As the Eastern Distinct Population of the Steller sea lion (now delisted under the Endangered Species Act [ESA]) generally occurs from central California north to southeast Alaska, it is not addressed in this document.

12 The rough-toothed dolphin (*Steno bredanensis*) and false killer whale (*Pseudorca crassidens*) are not addressed in this document as their occurrence in the area likely represents extralimital occurrences (Douglas et al. 2014).

TABLE 3-9 Marine Mammals of Southern California[a]

Species	Status[b]	Population Estimate (Minimum Estimate)	Occurrence/Distribution in Southern California
Order Cetacea: Suborder Mysticeti (baleen whales)			
Balaenoptera acutorostrata scammoni (North Pacific minke whale)	–	478 (202)	Occur year-round off California. Winter range includes Southern California Bight with a small portion residing there throughout the summer, especially around the northern Channel Islands.
Balaenoptera borealis borealis (Sei whale – northern hemisphere subspecies)	E/D	126 (83)	Rare in California waters. Usually observed in deeper waters of oceanic areas far from the coastline.
Balaenoptera musculus musculus (Blue whale – northern hemisphere subspecies)	E/D	1.647 (1,551)	First observed around the Channel Islands in May/June and are present on the continental shelf in the area from August to November. Tend to aggregate in the Santa Barbara Channel along the shelf break (seaward of 200-m line).
Balaenoptera physalus physalus (Fin whale – northern hemisphere subspecies)	E/D	3,051 (2,598)	Occur year-round off central and southern California, peaking in summer and fall. In Southern California Bight, summer distribution is generally offshore and south of the northern Channel Island chain.
*Eubalaena japonic*a (North Pacific right whale)	E/D	31 (25.7)	Very few sightings off southern California.
Eschrichtius robustus (Gray whale – Eastern North Pacific population)	DL	20,990 (20,125)	Generally present from December through May.
Megaptera novaeangliae (Humpback whale)	E/D	1,918 (1,855)	Feeds off California in summer and fall. Occurs throughout the western two-thirds of the Santa Barbara Channel. Tends to concentrate along the shelf break north of the Channel Islands.

TABLE 3-9 (Cont.)

Species	Status[b]	Population Estimate (Minimum Estimate)	Occurrence/Distribution in Southern California
Order Cetacea: Suborder Odontoceti (toothed whales and dolphins)			
Delphinus capensis capensis (Long-beaked common dolphin)	–	107,016 (76,224)	Prefer shallow waters closer to the coast (e.g., 50–100 nautical miles) and on the continental shelf. Commonly found from Baja California northward to central California.
Delphinus delphis delphis (Short-beaked common dolphin)	–	411,211 (343,990)	Primarily oceanic and offshore, but also along continental slope in waters 650 to 6,500 ft deep. Prefer waters altered by underwater geologic features where upwelling occurs. Found off California coast especially during warmer months.
Globicephala macrorhynchus (Short-finned pilot whale)	–		Found primarily in deep waters where there is a high density of squid. Observed south of Point Conception.
Grampus griseus (Risso's dolphin)	–	6,272 (4,913)	Present off southern California year-round with highest densities along the shelf break.
Lagenorhynchus obliquidens (Pacific white-sided dolphin)	–	26,930 (21,406)	Inhabits waters from the continental shelf to deep open ocean. Primarily occurs during colder water months. Moderate densities in Santa Barbara Channel and near the northern Channel Islands.
Lissodelphis borealis (Northern right whale dolphin)	–	8,334 (6,019)	Rare south of Point Conception in summer. During winter they are distributed from central California south. Highest annual densities over the shelf north of Point Conception.
Orcinus orca (Killer whale)	–	240 (162)	Observed west of San Miguel Island and over the shelf north of Point Conception.
Phocoena phocoena vomerina (Harbor porpoise)	–	2,917 (2,102)	The Morro Bay stock occurs from Point Conception north to just south of Monterey Bay.

1 **TABLE 3-9 (Cont.)**

Species	Status[b]	Population Estimate (Minimum Estimate)	Occurrence/Distribution in Southern California
Phocoenoides dalli dalli (Dall's porpoise)	–	42,000 (32,106)	Observed in offshore, inshore, and nearshore oceanic waters. Common in winter. Western Santa Barbara Channel is an area of higher densities.
Physeter macrocephalus (Sperm whale)	E/D	2,106 (1,332)	Present in offshore waters year-round with peak abundance during migrations from April to mid-June and from late August through November. Generally found in waters with depths >1,000 m.
Stenella coeruleoalba (Striped dolphin)	–	10,908 (8,231)	Prefers oceanic and deep waters. Often linked to upwelling areas and convergence zones. Infrequently observed in project area.
Tursiops truncatus truncatus (Bottlenose dolphin)	–	1,329 (974)	California coastal stock occurs primarily from Point Conception south within 1 km of shore. The California/Oregon/Washington offshore stock has a more-or-less continuous distribution off California.
Order Carnivora: Suborder Caniformia (includes seals and sea otters)			
Arctocephalus townsendi (Guadalupe fur seal)	T/D	7,408 (3,028)	Regularly occurs in the Channel Islands. Breeding occurs off the coast of Baja California, Mexico. A birth was reported on San Miguel Island.
Callorhinus ursinus (Northern fur seal)	–	12,844 (6,722)	Breeds in southern California and is present year-round. Breeds on San Miguel Island. Most fall and winter sightings are in offshore waters west of San Miguel Island.
Enhydra lutris nereis (Southern sea otter)	T/D	2,826 (2,723)	Occurs along mainland coast from San Mateo County south to Santa Barbara County with a small colony also on San Nicolas Island. Typically inhabit waters <18-m deep and rarely move more than 2 km offshore.
Mirounga angustirostris (Northern elephant seal)	–	179,000 (81,368)	Breeds in southern California and are present year-round. San Miguel and San Nicolas are the major rookery islands. Some also born on Santa Rosa, Santa Barbara, and San Clemente islands.

TABLE 3-9 (Cont.)

Species	Status[b]	Population Estimate (Minimum Estimate)	Occurrence/Distribution in Southern California
Phoca vitulina richardii (Pacific harbor seal)	–	30,968 (27,348)	Breed in southern California and are present year-round. Spend most of their time throughout fall and winter at sea. Haul out on all Channel Islands and on beaches along the mainland, particularly from Ventura County northward.
Zalophus californianus californianus (California sea lion)	–	296,750 (153,337)	Breed in southern California and are present year-round. Breed on San Miguel, San Nicolas, Santa Barbara, and San Clemente islands. Highest densities in Santa Barbara Channel in nearshore waters, with moderate densities in nearshore waters north of Point Conception.

[a] As the Eastern Distinct Population of the Steller sea lion generally occurs from central California north to southeast Alaska, it is not addressed in this EA. One Steller sea lion (*Eumetopias jubatus*) was reported in the region during cruises conducted between 2004 and 2008 (Douglas et al. 2014). The rough-toothed dolphin (*Steno bredanensis*) and false killer whale (*Pseudorca crassidens*) are also not included as their occurrence in the area likely represents extralimital occurrences (Douglas et al. 2014).

[b] Status: D = depleted under the Marine Mammal Protection Act (MMPA); DL = delisted under the ESA; E = endangered under the Endangered Species Act (ESA); T = threatened under the ESA; – = not listed. All species are protected under the MMPA.

Sources: Carretta et al. (2014, 2015); NOAA Fisheries (2015d–j).

northward and southward migrations of gray whales overlap in southern California, with individuals observed moving in both directions during January and February (CMLPAI 2009). Because gray whales migrate close to shore, they may often be seen from shore in some portions of the project area, such as the coast along Santa Barbara. Most of the baleen whales mainly consume euphausiid and copepod crustaceans, while the toothed whales, dolphins, and seals generally feed on schooling fishes and squid. The killer whale preys upon fishes, marine mammals, and seabirds, and the southern sea otter preys mainly on benthic macroinvertebrates.

The more frequently encountered small cetaceans observed in shallow depth waters (<2,000 m) off southern California are the short-beaked common dolphins (*Delphinus delphis*), long-beaked common dolphin (*D. capensis*), Pacific white-sided dolphin (*Lagenorhynchus obliquidens*), Risso's dolphin (*Grampus griseus*), northern right whale dolphin (*Lissodelphis borealis*), and Dall's porpoise (*Phocoenoides dalli*) (Douglas et al. 2014). These species occur throughout the year. However, both density and abundance of these species in shallow depth waters differ between winter-spring and summer-fall (Table 3-10).

TABLE 3-10 Density and Abundance of Most Frequently Observed Small Cetacean Species off Southern California in Shallow Water Depths (<2,000 m)

Species Season	Density (No./1,000 km^2)	Uncorrected Abundance (No./71,407 km^2)
Short-beaked common dolphin (*Delphinus delphis*)		
Winter–spring	307.83	21,981
Summer–fall	1,319.69	94,235
Long-beaked common dolphin (*Delphinus capensis*)		
Winter–spring	30.90	2,207
Summer–fall	687.87	49,118
Pacific white-sided dolphin (*Lagenorhynchus obliquidens*)		
Winter–spring	110.57	7,896
Summer–fall	29.24	2,088
Risso's dolphin (*Grampus griseus*)		
Winter–spring	35.65	2,546
Summer–fall	3.90	279
Northern right sided dolphin (*Lissodelphis borealis*)		
Winter–spring	107.31	7,662
Summer–fall	6.72	480
Dall's porpoise (*Phocoenoides dalli*)		
Winter–spring	45.5	3,249
Summer–fall	2.11	151

Source: Douglas et al. (2014).

Campbell et al. (2014, 2015) also reported on the spatial distribution patterns for several cetacean species off southern California. The humpback whale, gray whale, bottlenose dolphin (*Tursiops truncatus truncatus*), Risso's dolphin, and long-beaked common dolphin concentrate in coastal and shelf waters; whereas, the sperm whale (*Physeter macrocephalus*) was detected exclusively in pelagic waters. Blue whales, fin whales, short-beaked common dolphins, Pacific white-sided dolphins, and Dall's porpoise had broad distributions occurring in coastal, shelf, and pelagic waters.

3.5.3.2 Seals, Sea Lions, and Sea Otters

The six species in the order Carnivora present in the project area includes two species in the family Phocidae (true seals): the northern elephant seal (*Mirounga angustirostris*) and Pacific harbor seal (*Phoca vitulina richardii*); three species in the family Otariidae (eared seal): California sea lion (*Zalophus californianus californianus*), Guadalupe fur seal (*Arctocephalus townsendi*), and northern fur seal (*Callorhinus ursinus*); and one species in the family Mustelidae (otters, weasels, and badgers): southern sea otter (*Enhydra lutris nereis*). The Guadalupe fur seal and the southern sea otter are Federally threatened. These species occur throughout portions of the Southern Pacific OCS Planning Area, and mainland coastal areas and the northern Channel Islands support numerous haulout and rookery sites for many of these species. The California sea lion also uses offshore platforms as haulouts throughout the year (Table 3-11).

The northern elephant seal hauls out during the breeding season (December through March) and during the molt (April through August). Most sites used for breeding are also used for molting. Large numbers of juveniles also haul out at these sites in fall preceding the breeding season. The northern elephant seal migrates north to feeding grounds twice a year. When not on

TABLE 3-11 Seal Haulout and Rookery Sites

Species	Haulout Site	Rookery Site
Pacific harbor seal	Point Conception, Goleta Point, Rincon Point, Point Mugu, Purisima Point, Santa Rosa Island, Santa Cruz Island, Anacapa Island	Rincon Point
California sea lion	San Miguel Island, Santa Rosa Island, Anacapa Island, Santa Cruz Island, offshore platforms	San Miguel Island, Anacapa Island, Santa Cruz Island
Guadalupe fur seal	San Miguel Island	San Miguel Island
Northern elephant seal	San Miguel Island, Santa Rosa Island	Santa Rosa Island
Northern fur seal	San Miguel Island	San Miguel Island

Sources: CMLPAI (2005, 2009).

land, they spend most of their time underwater probably feeding on deepwater benthic species such as rockfish, squid, swell sharks, and ratfish (CMLPAI 2009).

The southern Channel Islands have the largest concentration of Pacific harbor seals in California. Pacific harbor seals are year-round residents at most of their haulout sites, but abundance varies seasonally. However, Pacific harbor seals are also prevalent in the northern Channel Islands and along portions of the mainland within the project area. The highest numbers occur during the breeding season (March to June) and the molt (June to July). Their diet is primarily fish, shellfish, and crustaceans (NOAA Fisheries 2015b).

The California sea lion breeds mainly on offshore islands in the southern portion of their range. They occur around a number of the Channel Islands. They opportunistically feed on seasonally abundant schooling fish and squid. Feeding tends to occur in cool upwelling waters of the continental shelf (CMLPAI 2009).

The Guadalupe fur seal is a pelagic species for most of the year. Breeding occurs almost entirely on Isla de Guadalupe, Mexico, from May to July (CMLPAI 2009; NOAA Fisheries 2015c). Their northern range is the Channel Islands (CMLPAI 2009), with a small population occurring on San Miguel Island (NOAA Fisheries 2015c). They feed in deep waters on krill, squid, and small schooling fish (CMLPAI 2009).

One of only three breeding sites in the United States for the northern fur seal occurs on San Miguel Island (the other locations are the Pribilof Islands and Bogoslof Island).[13] The breeding season can range from May to early November. Peak pupping is early July. After the breeding season, the northern fur seal remains pelagic. Southern California is at the southern boundary of its range. Northern fur seals that breed on San Miguel Island tend to remain in the area throughout the year. Major El Niño events have caused declines in the northern fur seal population on San Miguel Island. However, the population began to recover in 1999, and now numbers more than 9,000 individuals. The diet of the northern fur seal includes fish and squid (NOAA Fisheries 2015a).

Within California, the southern sea otter occurs from Pigeon Point, San Mateo County, south to 5 km west of Gaviota State Beach, Santa Barbara County, and on San Nicolas Island off of Ventura County (Hatfield and Tinker 2014). Overall, sea otter numbers have increased on the mainland and San Nicolas Island since the early 1990s. In 2014, the total (3-year average) mainland numbers were 2,881 and 63 for San Nicolas Island. On the mainland, 56 sea otters were counted southeast of Point Conception (the southern end of the mainland range of the sea otter) (Hatfield and Tinker 2014). The trend in abundance of the mainland population remains relatively flat, demonstrating a 5-year average growth rate of 0.2%. However, the growth rate in the southern portion of the range (Cayucos to Gaviota) is negative, −3.3%; although southeast of Point Conception there has been a positive growth rate trend of 2.8% (Hatfield and Tinker 2014). In California, sea otters rarely eat fish; most of their diet is large invertebrates such as abalone, crabs, and sea urchins (CMLPAI 2009).

[13] A small population has developed on South Farallon Island off the coast of San Francisco, presumably immigrants from San Miguel Island (NOAA Fisheries 2015a).

3.5.3.3 Threatened and Endangered Marine Mammals

All marine mammals that occur in the area are protected under the Marine Mammal Protection Act (MMPA). Eight species are listed under the ESA (Table 3-9). The sei whale (*Balaenoptera borealis borealis*), blue whale, fin whale, North Pacific right whale (*Eubalaena japonica*), humpback whale, and sperm whale are endangered; while the Guadalupe fur seal and the southern sea otter are threatened. All of the Federally listed species are under the jurisdiction of National Oceanic and Atmospheric Administration (NOAA) Fisheries, except the southern sea otter which is under the jurisdiction of the U.S. Fish and Wildlife Service (USFWS).

3.5.4 Marine and Coastal Birds

A diverse assemblage of birds occurs within southern California. For example, 387 species are recorded (as of November 2011) on or within 1.5 km of the shore of San Miguel, Santa Rosa, Santa Cruz, Anacapa, and Santa Barbara islands which compose Channel Islands National Park (Collins 2011). Most birds are afforded protection under the Migratory Bird Treaty Act (MBTA), while the Federally listed threatened and endangered species are protected under the ESA. The Bald Eagle (*Haliaeetus leucocephalus*) is afforded protection under the Bald and Golden Eagle Protection Act.[14] Some bird species breed in southern California, while others are non-breeding summer residents, winter residents, or migrants. The two groups of birds most likely to be impacted by OCS O&G developments are seabirds and shorebirds. Waterfowl and wading birds that occupy coastal wetlands and estuaries may also be affected by O&G activities.

3.5.4.1 Seabirds

Mason et al. (2007) identified 54 seabird species between Cambria, California, and the Mexican border, which encompasses the area of the southern California OCS platforms. Seabird densities averaged 33.7 birds/km^2 (range of 0.0 to 12,244 seabirds/km^2) throughout the surveyed area. Average densities were 11.3 seabirds/km^2 for at-sea transects and 70.9 seabirds/km^2 for coastal transects. Highest at-sea densities were near the Channel Islands in January and north of Point Conception in May, with lowest densities in the southwestern portion of the Southern California Bight in all survey months (Mason et al. 2007). Survey results (conducted from May 1999 to January 2002) indicate that seabird abundance has declined off the southern California coast possibly due to environmental degradation in the area or climate change. Species with dramatic decreases included the Common Murre (*Uria aalge*), Sooty Shearwater (*Puffinus griseus*), and Bonaparte’s Gull (*Larus philadelphia*) (Mason et al. 2007).

Nearshore seabird species occupy relatively shallow waters close to shore. Common nearshore species include the Common Loon (*Gavia immer*), Pacific Loon (*G. pacifica*), Western Grebe (*Aechmophorus occidentalis*), and Surf Scoter (*Melanitta perspicillata*)

[14] The Bald Eagle was delisted from the ESA in 2007. Prior to delisting, Bald Eagles were successfully introduced into the project area. Nesting occurs on several of the Channel Islands (e.g., Santa Catalina and Santa Cruz Islands) (CMLPAI 2009).

(Mason et al. 2007). Nearshore species are most numerous in winter months, with relatively few remaining during the summer (MMS 2001).

Pelagic seabirds generally occur over deeper waters compared with nearshore species. Common pelagic species off southern California include the Black-footed Albatross (*Phoebastria nigripes*), Sooty Shearwater, Black-vented Shearwater (*Puffinus opisthomelas*), Pink-footed Shearwater (*P. creatopus*), Leach's Storm-petrel (*Oceanodroma leucorhoa*), California Brown Pelican (*Pelecanus occidentalis*), cormorants (*Phalacrocorax* spp.), Red Phalarope (*Phalaropus fulicaria*), Red-necked Phalarope (*P. lobatus*), and the Common Murre (Mason et al. 2007). Although pelagic species are generally present throughout the year, their abundance varies seasonally. For example, the Sooty Shearwater and Pink-footed Shearwater are most abundant during summer months (although they do not breed in southern California) (Mason et al. 2007).

Common gulls and terns in the area include the California Gull (*Larus californicus*), Ring-billed Gull (*L. delawarensis*), Heermann's Gull (*L. heermanni*), Bonaparte's Gull, Black-legged Kittiwake (*Rissa tridactyla*), and Caspian Tern (*Hydroprogne caspia*). Densities of the gulls and terns tend to be highest along the mainland and Channel Island coasts and within the Santa Barbara Channel (Mason et al. 2007).

The migratory flyways for most seabirds are located farther offshore than the nearshore coastal region within which the OCS platforms are located. Spring coastal seabird migration begins in late February, with peak movement occurring between late March and early May. Fall movements of coastal seabirds generally occur between October and December (Johnson et al. 2011). Pelagic migratory species are most numerous from mid-April to early June and from mid-August to mid-October (Johnson et al. 2011).

Twenty seabird species breed in southern California, almost entirely on the Channel Islands (Mason et al. 2007). The Channel Islands provide essential nesting and feeding grounds for many of the seabirds in southern California. The islands support colonies of California Brown Pelicans, Scripps's Murrelets (*Synthliboramphus scrippsi*), Cassin's Auklet (*Ptychoramphus aleuticus*), Western Gulls (*Larus occidentalis*), Ashy Storm-petrels (*Oceanodroma homochroa*), Black Storm-petrels (*O. melania*), Double-crested Cormorants (*Phalacrocorax auritus*), Pigeon Guillemots (*Cepphus columba*), and Common Murres (NPS 2015).

Sydeman et al. (2012) identified "hotspots" of seabird abundance within the California Current Ecosystem along the west coast of North America from Vancouver Island, British Columbia, Canada, to Punta Eugenia, Baja California, Mexico. The hotspots are areas of consistently elevated abundance for a seabird species. Those identified within the general area of the southern California OCS platforms include Point Conception (Ashy Storm-petrel and Pink-footed Shearwater), San Miguel Island (Brandt's Cormorant [*Phalacrocorax penicillatus*]), south San Miguel Island (Pink-footed Shearwater), Santa Monica Basin (California Brown Pelican), Anacapa Island (California Brown Pelican), Santa Barbara Island (Western Gull), Santa Barbara Basin (California Brown Pelican and Western Gull), Santa Monica Basin (Black-vented Shearwater), Bolsa Bay (California Gull), Palos Verdes/Bolsa Chica (Elegant Tern

[*Sterna elegans*]), Santa Cruz Island (Red-necked Phalarope), Santa Cruz Basin (Pink-footed Shearwater), off San Juan Seamount (Red-necked Phalarope), and Santa Rosa/Cortes Ridge (Sooty Shearwater) (Sydeman et al. 2012).

3.5.4.2 Shorebirds

While more than 40 shorebird species are recorded from central and southern California, less than 25 species occur regularly in the area. Few shorebirds breed in the area; most species migrate to the area in the fall to overwinter and then leave in spring to return to their northern breeding grounds. Most shorebirds inhabit tidal wetlands, sandy beaches, and rocky shorelines (Hickey et al. 2003). Shorebird species in the area include Black-bellied Plover (*Pluvialis squatarola*), Semipalmated Plover (*Charadrius semipalmatus*), Willet (*Tringa semipalmata*), Wandering Tattler (*T. incana*), Whimbrel (*Numenius phaeopus*), Marbled Godwit (*Limosa fedoa*), Black Turnstone (*Arenaria melanocephala*), Sanderling (*Calidris alba*), Western Sandpiper (*C. mauri*), Least Sandpiper (*C. minutilla*), Spotted Sandpiper (*Actitis macularius*), Dunlin (*C. alpina*), and Long-billed Curlew (*Numenius americanus*). Shorebirds that do breed in the area include the Black Oystercatcher (*Haematopus bachmani*), Black-necked Stilt (*Himantopus mexicanus*), Killdeer (*Charadrius melodus*), and the Federally threatened Western snowy Plover (*C. nivosus nivosus*) (Arata and Pitkin 2009; Rodriguez et al. 2011). Areas commonly used by shorebirds include Mugu Lagoon, Santa Clara River mouth, Carpinteria Marsh, Goleta Slough, and the Santa Ynez River mouth (MMS 2001).

Rodriguez et al. (2011) conducted monthly counts of shorebirds on 14 beaches in Ventura County from July 2007 through June 2010. The mean number of shorebirds sighted per kilometer was 77.5 (34.8 for the six focal shorebird species). The range in numbers of birds counted per kilometer for the six focal species during the 3-year study period were Black-bellied Plover (0.5 to 0.8/km), Snowy Plover (1.9 to 5.4/km), Willet (5.8 to 10.4/km), Whimbrel (1.6 to 3.9/km), Marbled Godwit (1.6 to 6.8/km), and Sanderling (11.1 to 16.9/km).

3.5.4.3 Waterfowl and Wading Birds

Waterfowl and wading birds (e.g., ducks, geese, herons, egrets, and rails) inhabit coastal and interior wetlands. In the project area, they inhabit saltwater marshes such as Carpinteria Marsh and Mugu Lagoon and various river and stream mouths. About 25 species of wading birds have been reported from the coastal regions of central and southern California. Common species include Black-crowned Night Heron (*Nycticorax nycticorax*), Green Heron (*Butorides virescens*), Snowy Egret (*Egretta thula*), Great Egret (*Ardea alba*), Great Blue Heron (*A. herodias*), Virginia Rail (*Rallus limicola*), Sora (*Porzana carolina*), and American Coot (*Fulica americana*). Around 40 waterfowl species also occur in the coastal areas of central and southern California. Common waterfowl include Canada Goose (*Branta canadensis*), Green-winged Teal (*Anus crecca*), American Wigeon (*A. americana*), Northern Pintail (*A acuta*), Northern Shoveler (*A. clypeata*), and Cinnamon Teal (*A. cyanoptera*) (MMS 2001).

3.5.4.4 Special Status Bird Species

Table 3-12 lists the special status marine and coastal bird species within or near the project area.

Federally Listed Bird Species. Past analyses determined that a number of Federally listed bird species would not be affected by proposed offshore O&G activities. The current status of these species was reexamined, and listed species not considered in past analyses were also evaluated. We have determined that the continuation of existing offshore O&G development and production activities (including well stimulation activities) in the Southern California Planning Area will have no effect on the following listed species: Short-tailed Albatross (*Phoebastria albatrus*), Hawaiian Petrel (*Pterodroma sandwichensis*), California Condor (*Gymnogyps californianus*), and California Ridgway's Rail (*Rallus obsoletus obsoletus*). Brief descriptions of these species and the rationale for anticipated project effects on them follow.

Short-tailed Albatross. The Federally endangered Short-tailed Albatross is also a California species of special concern. It breeds on islands surrounding Japan. During the non-

TABLE 3-12 Special-Status Marine and Coastal Birds within or near the Project Area

Common Name	Scientific Name	Federal Status[a]	State Status[a]
Brant	*Branta bernicla*	–	SSC
Black-footed Albatross	*Phoebastria nigripes*	BCC	–
Short-tailed Albatross	*Phoebastria albatrus*	E	SSC
Pink-footed Shearwater	*Puffinus creatopus*	BCC	–
Black-vented Shearwater	*Puffinus opisthomelas*	BCC	–
Ashy Storm-Petrel	*Oceanodroma homochroa*	BCC	SSC
Black Storm-Petrel	*Oceanodroma melania*	–	SSC
Double-crested Cormorant	*Phalacrocorax auritus*	–	TW
Light-footed Ridgway's Rail	*Rallus obsoletus levipes*	E	E
Western Snowy Plover	*Charadrius nivosus nivosus*	T	SSC
Marbled Murrelet	*Brachyramphus marmoratus*	T	E
Scripps's Murrelet	*Synthliboramphus scrippsi*	C, BCC	T
Guadalupe Murrelet	*Synthliboramphus hypoleucus*	C, BCC	T
Cassin's Auklet	*Ptychoramphus aleuticus*	BCC	SSC
Rhinoceros Auklet	*Cerorhinca monocerata*	–	TW
Tufted Puffin	*Fratercula cirrhata*	–	SSC
California Gull	*Larus californicus*	–	TW
California Least Tern	*Sternula antillarum browni*	E	E
Elegant Tern	*Thalasseus elegans*	–	TW

[a] Status: C = candidate; BCC = bird of conservation concern; DE = delisted (formerly endangered); E = endangered; SSC = species of special concern; T = threatened; TW = taxa to watch; – = not listed.

breeding season, the Short-tailed Albatross regularly ranges along the Pacific Rim from southern Japan to the Gulf of Alaska, primarily along continental shelf margins. It is rare to casual but increasing offshore from British Columbia to southern California (Howell 2012). All recent records along the west coast have been stage 1 immatures (Howell 2012) which travel more broadly throughout the north Pacific than adults (USFWS 2014). Most individuals off California in recent years have been observed during fall and early winter, with a few records in late winter and early spring (Iliff et al. 2007). There have been 40 records of the species off California since 1977, with 36 records between 1998 and 2014. Nine of the 40 records have occurred in the Southern California Planning Area off the coast of San Luis Obispo and Santa Barbara counties, and around and beyond the Channel Islands. This species is not expected to occur with any regularity in the Southern California Planning Area site due to its rarity and the lack of recorded sightings in the vicinity of the project area; therefore, we have determined that the proposed activities will have no effect on this species.

Hawaiian Petrel. The Federally endangered Hawaiian Petrel breeds on the larger Hawaiian islands. The global population is composed of approximately 19,000 individuals, including an estimated 4,500 to 5,000 breeding pairs (USFWS 2011; Lebbin et al. 2010). Individuals have been recorded off of Oregon and California from April through October (Onley and Scofield 2007), with the California records occurring from April through early September. There are 12 records in the vicinity of the Southern California Planning Area; one was nearshore and the others were 24 to 100 mi offshore. Hawaiian Petrels make regular foraging excursions to areas off of northern California, but there does not appear to be a regular pattern of occurrence off central and southern California. As the Hawaiian Petrel is not expected to occur with any regularity in the Southern California Planning Area, the proposed activities will have no effect on this species.

California Condor. All free-ranging Federally endangered California Condors were removed from the wild by 1987 for captive breeding. Since 1992, California Condor chicks have regularly been released to the wild, and the total world population now numbers about 400 birds; 235 of which are free-flying wild birds in California, Arizona, Utah, and Baja California, Mexico (USFWS 2013a). In California, California Condors now inhabit the mountain ranges that surround the southern part of the San Joaquin Valley. Those that live along the coast in the Big Sur area on the Monterey County coastline have been observed feeding on the carrion of whales, California sea lions, and other marine species along the marine coastline (USFWS 2013a). We are not aware of any observations of California Condors feeding along the marine coastline south of Big Sur, as most of the birds south of Monterey County are restricted to more inland mountain ranges in San Luis Obispo, Santa Barbara, Ventura, and Los Angeles counties. Because of their absence from the marine coastline south of Monterey County, we have determined that the proposed activities will have no effect on this species.

California Ridgway's Rail. The Federally endangered California Ridgway's Rail, formerly known as the California Clapper Rail (*Rallus longirostris obsoletus*), is generally restricted to the San Francisco Bay area. The California Ridgway's Rail was formerly a breeding species in Morro Bay and Elkhorn Slough but was extirpated from those locations. Records of California Ridgway's Rail sightings beyond San Francisco Bay are now sparse (USFWS 2013b). Due to the species current distribution, we have determined that the proposed activities will have no effect on this species.

The following Federally listed bird species occur within the Southern California Planning Area and could potentially be affected by project-related activities: Light-footed Ridgway's Rail (*Rallus obsoletus levipes*), Pacific Coast population of the Western Snowy Plover (*Charadrius nivosus nivosus*), Marbled Murrelet (*Brachyramphus marmoratus marmoratus*), and California Least Tern (*Sternula antillarum browni*). Brief descriptions of these species follow. Potential project-related impacts are provided in Section 4.5.1.4.

Light-footed Ridgway's Rail. The endangered Light-footed Ridgway's Rail was formerly known as the Light-footed Clapper Rail (*Rallus longirostris levipes*). A recovery plan was approved in 1979 (USFWS 1979). Critical habitat has not been designated for this subspecies. Habitat loss and degradation were the primary reason for ESA listing.

The Light-footed Ridgway's Rail inhabits coastal salt marshes from the Carpinteria Marsh in Santa Barbara County, California, to Bahia de San Quintin, Baja California, Mexico (Zembal et al. 1989, 1998). Dense growths of cordgrass (*Spartina foliosa*) and pickleweed (*Salicornia* sp.) are conspicuous components of rail habitat, and nests are located most frequently in cordgrass. Light-footed Ridgway's Rails construct loose nests of plant stems, either directly on the ground when in pickleweed or somewhat elevated when in cordgrass (USFWS 1979). Although nests are usually located in the higher portions of the marsh, they are buoyant and will float up with the tide. The laying of eggs occurs from mid-March to the end of June, but mostly from early April to early May. The incubation period is about 23 days, and young can swim soon after hatching.

Historically, Light-footed Ridgway's Rails probably occupied most of the salt marshes in the region, but no more than 24 marshes have been occupied since about 1980 (Zembal and Hoffman 1999). Approximately 500 pairs are believed to be left in California, with most occurring in Upper Newport Bay, Seal Beach, and the Tijuana Marsh. The vast majority (more than 95%) of the remaining Light-footed Ridgway's Rails are in Orange and San Diego counties. In 2013, a total of 525 pairs exhibited breeding behavior in 22 marshes in southern California (Zembal et al. 2013). This is the largest Statewide breeding population detected since the counts began in 1980, and represents an 18.5% increase over the former high count in 2007. It also represents the third successive year of record-breaking high counts. Although surveys have not been conducted in Baja California for several years, the Baja population is thought to consist of at least 400 to 500 pairs.

In the vicinity of the Santa Barbara Channel, there are two marshes that are, or have the potential to be, occupied by Light-footed Ridgway's Rails. These are Carpinteria Marsh in Santa Barbara County and Mugu Lagoon in Ventura County. The next closest occupied location is the Seal Beach National Wildlife Refuge (NWR) in Orange County. These locations represent the northern extent of the subspecies range along the California coast. The subpopulation at

Mugu Lagoon fluctuated between 3 and 7 pairs for nearly 20 years until recent augmentations with translocated birds from Newport Bay fostered its growth. During 2010 through 2014, there was an average of 18 pairs and five unmated males in Mugu Lagoon on Naval Base Ventura County (Pereksta 2015a). The increased population at this location appears to have led to an expansion of habitat use within the lagoon. For example, in 2004, a pair of rails was observed attempting to breed in the eastern arm of the lagoon for the first time in many years (Zembal et al. 2006). In Santa Barbara County, the Light-footed Ridgeway's Rail was formerly more widespread, but the loss of habitat and other factors restricted it to the Carpinteria Salt Marsh during the late 1900s (Lehman 2014). Approximately 20 pairs were there in the early 1980s, dropping to just one individual by 2004. None were recorded after 2004 until a single individual was heard vocalizing there in 2011.

Western Snowy Plover. The Pacific Coast population of the Western Snowy Plover is listed as threatened. The primary reasons for its listing are loss and degradation of habitat and human disturbance. A final recovery plan has been adopted (USFWS 2007). Critical habitat for the species was last revised in 2012 (USFWS 2012). The revised critical habitat for the Western Snowy Plover includes 60 units totaling 24,526 acres (9,925 ha). Thirty-five of these units occur along the coast of the Southern California Planning Area, comprising 6,117 acres (2,475 ha) (USFWS 2012). This acreage is 25% of the total critical habitat designation.

The Pacific Coast population of the Western Snowy Plover breeds on the Pacific Coast from southern Washington to southern Baja California, Mexico. It nests in depressions in the sand above the drift zone on coastal beaches, sand spits, dune-backed beaches, sparsely vegetated dunes, beaches at creeks and river mouths, and salt pans at lagoons and estuaries. The breeding season extends from early March to late September, with birds at more southerly locations beginning to nest earlier in the season than birds at more northerly locations (USFWS 1999). In most years, the earliest nests on the California coast generally occur during the first to third week of March. Peak nesting in California occurs from mid-April to mid-June, while hatching lasts from early April through mid-August.

Western Snowy Plover chicks leave the nest within hours after hatching to search for food. Adult plovers do not feed their chicks but lead them to suitable feeding areas. The chicks reach fledging age approximately 1 month after hatching; however, broods rarely remain in the nesting area throughout this time. Plover broods may travel along the beach as far as 4 mi (6.4 km) from their natal area.

Western Snowy Plovers are primarily visual foragers. They forage for invertebrates across sandy beaches from the swash zone to the macrophyte wrack line of the dry upper beach. They also forage in dry sandy areas above the high tide, on salt flats, and along the edges of salt marshes and salt ponds (USFWS 1993).

In winter, Western Snowy Plovers occur on many of the beaches used for nesting as well as on beaches where they do not nest, in man-made salt ponds, and on estuarine sand and mud flats. The winter range is somewhat broader and may extend to Central America

(Page et al. 1995). During winter, the majority of the birds occur south of Bodega Bay, California (Page et al. 1986).

The Western Snowy Plover was formerly found on quiet beaches the length of the State, but it has declined in abundance and is discontinuous in its distribution. Habitat degradation caused by human disturbance, urban development, introduced beachgrass (*Ammophila* spp.), and expanding predator populations have led to declines in nesting areas and the size of breeding and wintering populations (USFWS 2007). The summer window survey conducted in 2014 found 2,016 birds throughout Washington, Oregon, and California.

In the Southern California Planning Area, Western Snowy Plovers breed or winter along the coasts of San Luis Obispo, Santa Barbara, Ventura, Los Angeles, Orange, and San Diego Counties from San Carpoforo Creek in northern San Luis Obispo County to Border Field State Park in San Diego County. They also occur on several of the Channel Islands, including San Miguel, Santa Rosa, Santa Cruz, San Nicolas, and San Clemente islands. From 2010 through 2014, an average of 1,100 breeding adults occurred in this area, which is 58% of breeding adults in the range of the listed population. Significant breeding areas within this stretch of coast include the Morro Bay Sandspit, Oceano Dunes State Vehicular Recreation Area, the Guadalupe Dunes, Vandenberg Air Force Base beaches, Coal Oil Point, Ventura Beaches (McGrath, Mandalay, and Hollywood), Ormond Beach, Naval Base Ventura County, San Nicolas Island, the Bolsa Chica Ecological Reserve, and Camp Pendleton. The average number of wintering Western Snowy Plovers in this area from 2008 through 2012 was 2,463, approximately 70% of the wintering population along the California coast.

Marbled Murrelet. The Marbled Murrelet is listed as threatened within the States of Washington, Oregon, and California (USFWS 1992). It spends most of its life in the nearshore marine environment, but nests and roosts inland in low-elevation old growth forests, or other forests with remnant large trees. Revised critical habitat for the species was published in 2011 (USFWS 2011). No marine areas were designated as critical habitat, and none of the terrestrial units are south of the Santa Cruz Mountains (the southern extent of known breeding along the Pacific Coast), which is approximately 100 mi (160 km) north of the Southern California Planning Area.

While the Marbled Murrelet does not nest in the vicinity of the project area, individuals from the population nesting in the Santa Cruz Mountains (and perhaps from more northerly populations) do disperse to the coast and offshore waters of San Luis Obispo and Santa Barbara counties. Marantz (1986) characterized them as a rare transient and winter visitors offshore, but possibly regular in late summer in San Luis Obispo County. Lehman (2014) described the species as a very rare late-summer, fall, and winter visitor along the Santa Barbara County coast, but somewhat regular in late summer in the Point Sal/north Vandenberg Air Force Base area. The San Luis Obispo coast extending south to Point Sal in Santa Barbara County is an important wintering area for the species (Peery et al. 2008). Point Sal is more than 15 mi (24 km) north of Irene (the northernmost platform in the Southern California Planning Area).

A review of records in eBird (2015) shows Marbled Murrelet observations along the coast from Arroyo de la Cruz in northern San Luis Obispo County to the Purisima Point area on Vandenberg Air Force Base. Areas with concentrations of Marbled Murrelet observations include San Simeon Bay, offshore of San Simeon State Park, Cayucos, Morro Bay, San Luis Obispo Bay, and off the Santa Maria River mouth. These records show peaks of occurrence along this stretch of coast in mid-January, May to early June, and mid-August to early November. Marbled Murrelets occur less frequently south of Point Conception; however, they are observed occasionally off of Ventura, along the Malibu coastline, and in Santa Monica Bay.

Marbled Murrelets forage at sea by pursuit diving in relatively shallow waters, usually between 66 and 262 ft (20 and 80 m) in depth, with the majority of birds found as singles or pairs in a band 985 to 6,560 ft (300 to 2,000 m) from shore (Strachan et al. 1995). After the breeding season, some birds disperse and are less concentrated in nearshore coastal waters, as is the case with some other alcids. Ainley et al. (1995) conducted ship-based surveys off central California and detected most Marbled Murrelets within 4 mi (7 km) of shore, with the largest number occurring 2 to 3 mi (3 to 5 km) offshore. They observed one individual 15 mi (24 km) offshore near the edge of the continental shelf break.

California Least Tern. The California Least Tern was listed as endangered in 1970 (USFWS 1970). The recovery plan for the species was first published in 1980 (USFWS 1980) and revised in 1985 (USFWS 1985). Critical habitat has not been designated. The primary reasons for its listing were habitat loss, human disturbance, and predation. In the 5-year review of the California least tern, it was recommended to downlist the species to threatened (USFWS 2006). However, this recommendation has not yet been enacted.

The California Least Tern is a summer visitor to California. It breeds on sandy beaches close to estuaries and embayments discontinuously along the California coast from San Francisco Bay south into Baja California. The earliest spring migrants arrive in the San Diego area after the first week in April and reach the greater San Francisco Bay area by late April (Small 1994). Nesting colonies are usually located on open expanses of sand, dirt, or dried mud, typically in areas with sparse or no vegetation. Colonies are also usually located in close proximity to a lagoon or estuary where they obtain most of the small fish the birds consume, although they may also forage up to 2 to 3 mi (3 to 5 km) offshore. Nests consist of a shallow scrape in the sand, sometimes surrounded by shell fragments. Eggs (usually two per clutch) are laid from mid-May to early August. Incubation takes 20 to 28 days, and young fledge in about 20 days (USFWS 1980). California Least Terns are fairly faithful to breeding sites and return year after year regardless of past nesting success. In the Southern California Planning Area, California Least Terns breed along the coasts of San Luis Obispo, Santa Barbara, Ventura, Los Angeles, and Orange counties from Oceano Dunes in San Luis Obispo County to the Tijuana River Estuary in San Diego County. Fall migration begins the last week of July and first week of August (USFWS 2006) when it departs for its wintering grounds in Central and South America. Most individuals are gone from southern California by mid-September.

In 1970, the California Least Tern population in California was estimated at 600 breeding pairs. Population growth rates have increased, especially since the mid-1980s, when active management was initiated at breeding colonies. Although the increase in the breeding population has not been consistent from year to year, the long-term trends have shown steady population growth. Fluctuations in the California Least Tern population are thought to be attributable to a combination of high levels of predation and low prey availability.

In the general area of the Southern California Planning Area, California Least Terns used as many as 28 sites for nesting in 2013. Range-wide survey results from 2013 reported a minimum of 3,904 breeding pairs, a maximum of 5,094 breeding pairs, and 5,406 nests in this region, which is approximately 92% of the nesting population and effort in California. Significant breeding areas within this stretch of coastline include Oceano Dunes, Vandenberg Air Force Base, McGrath State Beach, Hollywood Beach, Ormond Beach, Point Mugu, Venice Beach, Los Angeles Harbor, Seal Beach NWR, Bolsa Chica Ecological Reserve, Huntington State Beach, Burris Basin, Upper Newport Bay, Camp Pendleton, Batiquitos Lagoon, Mission Bay, Naval Base Coronado, Sweetwater Marsh NWR, and Tijuana River Estuary.

Studies conducted at some of the larger colonies in southern California show that at least 75% of all California Least Tern foraging activity during the breeding season occurs in the ocean (Atwood and Minsky 1983). Approximately 90 to 95% of ocean feeding occurred within 1 mi (1.6 km) of shore in water depths of 60 ft (18 m) or less. California Least Terns were rarely seen foraging at distances between 1 and 2 mi (1.6 and 3.2 km) from shore and were never encountered farther than 2 mi offshore (Atwood and Minsky 1983). However, there is evidence of some migration off California that occurs as far as 20 mi (32 km) offshore or more based on observations off southern California (Pereksta 2015b). Observations from offshore Mexico possibly corroborate this evidence (Howell and Engel 1993; Ryan and Kluza 1999).

Other Special Status Bird Species. In addition to the Federally listed species, the following special status species (e.g., USFWS Bird of Conservation Concern, Federal candidate, and/or State listed), which are considered globally rare, have a significant percentage of their populations within the Southern California Planning Area and could potentially be affected by project-related activities: Ashy Storm-petrel, Scripps's Murrelet, and Guadalupe Murrelet (*Synthliboramphus hypoleucus*). Brief descriptions of these species follow. Potential project-related impacts are provided in Section 4.5.1.4.

***Ashy Storm-Petrel*.** The Ashy Storm-petrel is a USFWS Bird of Conservation Concern and a California Species of Special Concern. It is one of the rarest storm-petrels in the world, with an estimated global population of no more than 10,000 individuals. The ashy storm-petrel breeds on offshore islands from central Mendocino County to the southern Channel Islands and the Todos Santos Islands off northwestern Baja California, Mexico (Carter et al. 2008). It moves to and from colonies at night. Its breeding season is spread throughout most of the year (Carter et al. 2008), although it typically occurs off southern California from March to October. This species breeds on six of the eight California Channel Islands (it does not breed on Santa Rosa and San Nicolas Islands).

The Ashy Storm-petrel forages widely in waters seaward of the continental shelf, near islands, and near the coast within the southern California Current ecosystem (Ainley et al. 1974; Briggs et al. 1987; Mason et al. 2007; Spear and Ainley 2007). The species does not travel significantly far from its colonies after breeding, and many birds remain offshore from their breeding grounds. However, some individuals can make short seasonal migrations. In fall, large numbers congregate in Monterey Bay and on the Cordell Bank. Fall concentrations in Monterey Bay probably include Farallon Islands' breeders, non-breeders, and fledglings along with individuals from southern populations (Ainley 1976).

Mason et al. (2007) observed Ashy Storm-petrels throughout their study area in the Southern California Bight and the waters north of Point Conception. Three specific areas where they found aggregations of Ashy Storm-petrels included the waters between Santa Cruz and San Nicolas Islands, the western Santa Barbara Channel, and 6 to 43 mi (10 to 70 km) offshore from San Miguel Island to Point Buchon. Briggs et al. (1987) observed Ashy Storm-petrels in greatest abundance near San Miguel Island from April to June. After October, birds occurred near San Clemente and Santa Catalina Islands, over the Santa Rosa-Cortes Ridge, and in the western Santa Barbara Channel to Point Buchon (Briggs et al. 1987). Based on the normal distribution and abundance, this species could occur within the project site year-round but has the highest potential of occurrence during the spring and fall months.

Scripps's and Guadalupe Murrelets. The Scripps's Murrelet and Guadalupe Murrelet are listed as threatened species by the State of California, candidates for Federal listing by the USFWS, and USFWS Birds of Conservation Concern. These species were formerly considered one species, the Xantus's Murrelet (*Synthliboramphus hypoleucus*), until a recent taxonomic revision by the American Ornithologists' Union (2012). The breeding range of these species is restricted to 12 nesting islands or groups of islands over a distance of 500 mi (800 km) in southern California and Baja, Mexico (Pacific Seabird Group 2002). The estimated remaining global population (Scripps's Murrelet <20,000 breeding birds; Guadalupe Murrelet <5,000 breeding birds) is concentrated during the breeding season in or near the breeding colonies on the Channel Islands and off the coast of northern Baja California. The two species typically nest in crevices, caves, under large rocks, on steep cliffs and canyons of offshore islands. The nesting period extends from February through July but may vary depending on food supplies (BirdLife International 2015).

The two murrelet species occur off southern California at different times of the year. The northern breeding Scripps's Murrelet occurs primarily from January to September, with a peak of abundance between late February and July. This species breeds from San Miguel Island south to the San Benito Islands off Baja California. The Guadalupe Murrelet breeds primarily on Guadalupe Island off Baja California; however, the species also breeds in small numbers on the San Benito Islands (Carter et al. 2005). It occurs off southern California from July to December.

During the breeding season, Scripps's Murrelets are generally concentrated in the Southern California Bight. Their distribution at sea during this time varies based on conditions in the marine environment. Whitworth et al. (2000) tracked Scripps's Murrelets nesting on Santa Barbara Island and found that they were dispersing to forage in cool upwelling areas averaging

39 mi (62 km) from the island in 1996 and 69 mi (111 km) in 1997. Briggs et al. (1987) observed bird concentrations around Santa Barbara Island and off San Diego in the breeding months (March to May), with birds off San Diego presumably from the nearby Coronado Islands. The greatest densities were near Santa Barbara and Anacapa Islands and north of Point Conception along the coast.

The pelagic distributions of both species overlap during the post-breeding dispersal in late summer and autumn, when both move primarily northward (Whitworth et al. 2000). At this time of year, they occur from southern Baja California to Vancouver Island, British Columbia, with the bulk between central Oregon and central Baja California, Mexico. Outside of the breeding season beyond foraging areas used by birds attending colonies, Karnovsky et al. (2005) found the murrelets (reported as Xantus's Murrelets) at an average ocean depth of 5,013 ft (range 85 to 15,056 ft or 1,528 m (range 26 to 4,589 m), with the highest densities occurring over the upper continental slope (depth: 656 to 3,280 ft or 200 to 1,000 m). Densities were moderately high over the outer slope (depth: 3,280 to 9,840 ft or 1,000 to 3,000 m) but were low over pelagic waters (depths > 9,840 ft or 3,000 m), as well as over the continental shelf (depth: 656 ft or 200 m). The average distance from the mainland was 52 mi (range 1.2 to 156 mi) or 83 km (range 2 to 251 km), with highest densities 16 to 93 mi (26 to 150 km) from shore. In central California waters, the murrelets were associated with high sea surface temperature, low salinity, and a shallow but highly stratified thermocline.

Therefore, these species could be found in the vicinity of the project site year-round; however, the greatest possibility for either of them to occur in the area is from January to September when Scripps's Murrelets are breeding on islands in the Southern California Bight.

3.5.5 Sea Turtles

Four sea turtle species occur in the Pacific OCS offshore of southern California, all of which are Federally listed as threatened or endangered under the ESA. Two species are endangered: the loggerhead turtle (North Pacific Ocean Distinct Population Species [DPS]) (*Caretta caretta*) and the leatherback turtle (*Dermochelys coriacea*); and two species are threatened: the green turtle (*Chelonia mydas*) and the olive Ridley turtle (*Lepidochelys olivacea*). The USFWS and NOAA Fisheries (2015) have proposed to remove the current range-wide threatened listing of the green turtle and in its place list eight DPSs as threatened and three DPSs as endangered. Southern California is within the range of the proposed threatened East Pacific DPS of the green turtle. No known nesting habitat for any of the sea turtles occurs in the project area. Threats to sea turtles include incidental capture, entanglement, and injury/death from fishing gear; marine debris; environmental contamination; disease, loss, or degradation of nesting habitat; beach armoring; artificial lighting; non-native vegetation; and directed harvest (NOAA Fisheries 2014a–c; 2015k,l).

The loggerhead turtle occurs worldwide in subtropical to temperate waters. In the eastern Pacific, loggerhead turtles are reported from Chile to Alaska. They are occasionally sited from the coasts of Washington and Oregon, but most records are of juveniles of the coast of California. The most important development habitats for juveniles along the eastern Pacific are off the west coast of Mexico, including the Baja Peninsula. The only known nesting areas in the North Pacific are found in southern Japan (NOAA Fisheries 2014c). Sightings in California tend to occur from July to September but can occur over most of the year during El Niño years when ocean temperatures rise. The leatherback is primarily pelagic, but occasionally enters coastal bays, lagoons, salt marshes, estuaries, creeks, and mouths of large rivers (California Herps 2015). Loggerhead turtles consume sponges, crustaceans, mollusks, jellyfish, worms, squid, barnacles, fish, and plants (NOAA Fisheries 2014c; California Herps 2015).

The leatherback turtle is mostly pelagic, but occasionally enter shallower waters of bays and estuaries (NOAA Fisheries 2015l). It is the most common sea turtle in U.S. waters north of Mexico. They tend to arrive in California waters in June and stay until mid-October when they move to waters off Hawaii. Diet is primarily jellyfish, but they also consume other invertebrates, small fish, and plant material (NOAA Fisheries 2015l: California Herps 2015). Revised critical habitat for the leatherback turtle (NOAA Fisheries 2012) encompasses the northern portion of the project area (encompassing Platform Irene). This segment of critical habitat stretches along the California coast from Point Arguello north to Point Arena east of the 9,842-ft (3,000-m) depth contour (NOAA Fisheries 2012).

The green turtle occurs worldwide in waters that remain above 20°C during the coldest months. It is uncommon along the California coast, but becomes more common south of San Diego (NOAA Fisheries 2015k). The green turtle is usually seen in El Niño years when ocean temperatures are warmer than normal. It inhabits shallow waters of lagoons, bays, estuaries, mangroves, eelgrass, and seaweed beds; it prefers areas with abundant vegetation in shallow, protected water. Green turtles consume seaweed, algae, and invertebrates, including sponges and jellyfish (NOAA Fisheries and USFWS 2007; California Herps 2015).

The olive Ridley turtle occurs worldwide in tropical to warm temperate waters. In the Eastern Pacific, they range from southern California to Chile. It is considered the most abundant sea turtle in the world, with an estimated 800,000 nesting females annually (NOAA Fisheries 2014b), but is rare along the California coast. In the eastern Pacific, olive Ridley turtles are highly migratory and spend much of their non-breeding life cycle in the oceanic zone (NOAA Fisheries and USFWS 2014), but are known to inhabit coastal areas (e.g., bays, estuaries) (NOAA Fisheries 2014b). Olive Ridley turtles are omnivorous and consume mollusks, crustaceans, jellyfish, sea urchins, fish, and occasional plant material (e.g., algae, seagrass) (NOAA Fisheries 2014b; California Herps 2015). They dive to depths up to 500 ft (150 m) to forage on benthic invertebrates (NOAA Fisheries 2014b).

3.6 RECREATIONAL AND COMMERCIAL FISHING

3.6.1 Commercial Fisheries

Although OCS operators are required to conduct activities without interfering with fishing activities, there is still a potential for fishers to be affected by O&G related activities on the Pacific OCS. Past effects have been associated with space use conflicts, OCS-associated seafloor debris, and reduced catch due to seismic surveys.

Commercial fishing occurs at various locations off the coast of southern and central California. The nearshore waters along the coast from Los Angeles to Monterey counties and the waters just off the Channel Islands contain beds of giant kelp that provide habitats for numerous species of commercially important fish and shellfish. The majority of commercially harvested fish are caught within these areas. About 64 commercial fish and shellfish species are fished using up to 15 gear types. Fishery seasons are established and regulated by the California Department of Fish and Wildlife (CDFW). Figure 3-15 shows the distribution of fish blocks in the project area, which are used to organize information on commercial fish catch. Fish blocks are 9- by 11-mi rectangles, or approximately 100 mi^2 of ocean area.

The CDFW reports the total number of pounds of commercial fishery species (comprised of fishes, invertebrates, and kelp) landed in California and the value of those landings annually for six reporting areas along the coast. From north to south, the California reporting areas are Eureka, San Francisco, Monterey, Santa Barbara, Los Angeles, and San Diego. The project area is located in the Santa Barbara reporting area (includes the ports of Morro Bay, Avila Beach, Oceano, Santa Barbara, Ventura, Oxnard, and Port Hueneme) and the Los Angeles reporting area (includes the ports of Santa Monica, Redondo Beach, San Pedro, Huntington Beach, Dana Point, and Los Angeles). Landing weights and values in the Santa Barbara reporting area for the years 2000–2013 are provided in Table 3-13. Nearly all of the landings in the Santa Barbara reporting area are from Santa Barbara, Ventura, Oxnard, and Port Hueneme harbors; nearly all the landings in the Los Angeles reporting area are from the San Pedro, Terminal Island, Long Beach, and Dana Point harbors. Except for Dana Point, all of these harbors are located in the vicinity of Federal and State oil platforms within the project area (Figure 3-15).

Many species of fish and invertebrates are caught and landed in commercial fisheries off the California coast. The most important species groups are benthic invertebrates, oceanic pelagic (epipelagic) fishes, demersal fish species, and anadromous species. Important invertebrate species include Dungeness crab, spiny lobster, squid, and oysters (though oysters are primarily harvested in coastal, nearshore waters). Important targeted fish species include anadromous salmon (primarily Chinook), tuna, and swordfish (epipelagic); and sablefish, halibut, and rockfishes (demersal). Many fishers in the project area do not fish for just one species, or use only one gear-type. Most switch fisheries during any given year depending on market demand, prices, harvest regulations, weather conditions, and fish availability. During 2013, landings of more than 111 million pounds of fish and invertebrates, with a value of more than $50.4 million, were reported for the Santa Barbara reporting area (CDFW 2015a).

Each species or species group is caught using various methods and gear types. Traps are used for crab, spiny lobster, and some demersal fish species; sardines are usually caught in surrounding lampara or purse nets; tuna are caught on surface troll lines or longlines; rockfishes are generally captured using trawls, set longlines, or trolling rigs; and squid are caught by encircling schools with a round-haul net, such as a purse seine or lampara net. Generally, fishing activities with the highest potential for interactions (or conflicts) with OCS activities (e.g., oil and gas operations) are bottom trawling (potential for snagging on pipelines, cables, and debris)

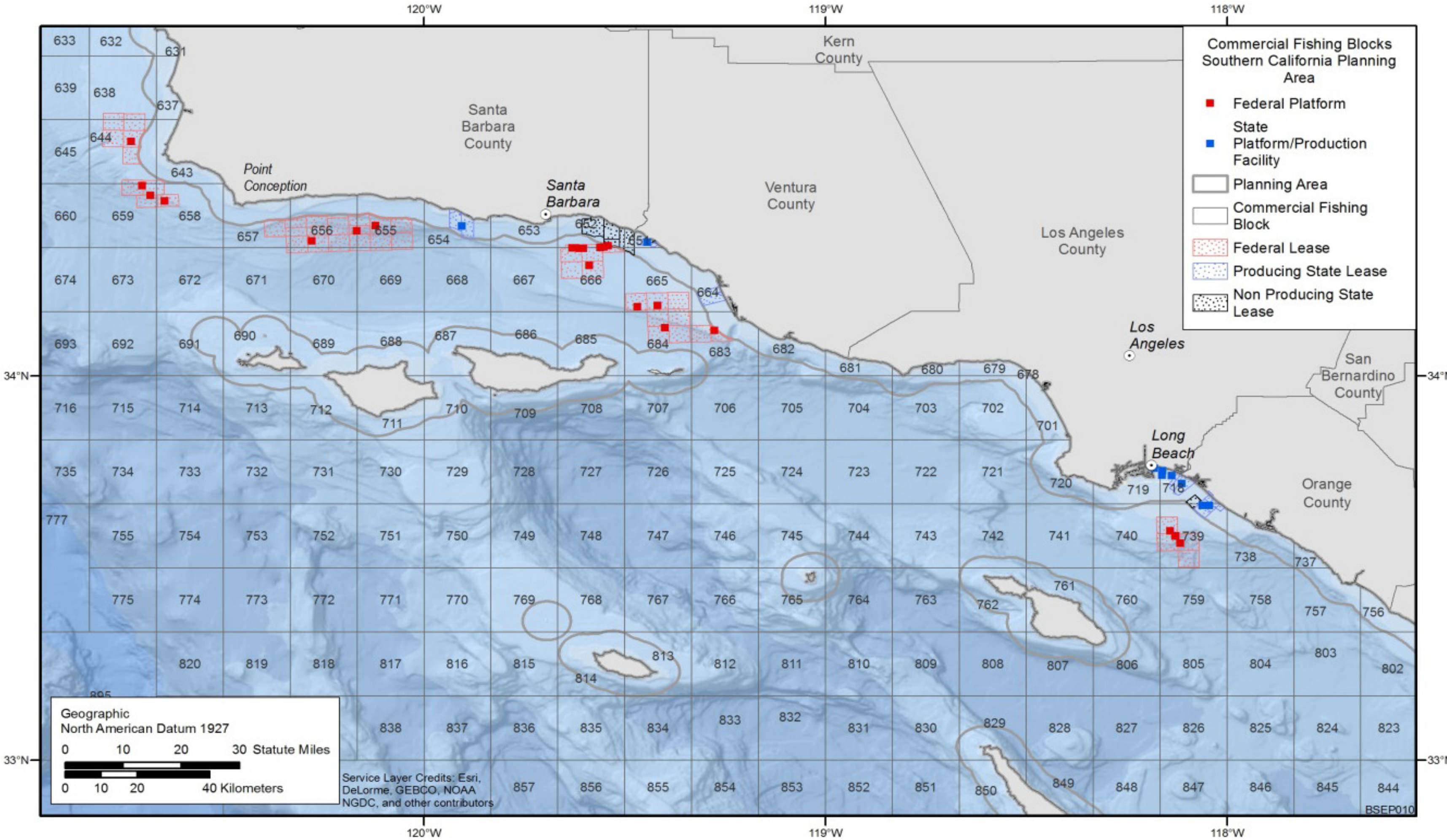

FIGURE 3-15 Commercial Fishing Blocks in the Project Area (Source: Perry et al. 2010)

TABLE 3-13 Annual Reported Landing Weights and Landing Values for the Commercial Fishery in the Santa Barbara Reporting Area, 2000–2013

	Santa Barbara Reporting Area		Los Angeles Reporting Area	
Reporting Year	Landing Weight (lb)	Landing Value ($)	Landing Weight (lb)	Landing Value ($)
2000	171,440,307	27,470,031	254,442,454	40,933,089
2001	109,956,541	17,600,164	218,641,818	31,603,239
2002	62,086,380	17,232,730	170,125,068	23,273,932
2003	60,373,853	22,906,278	88,473,636	18,942,786
2004	77,883,985	24,258,955	92,236,447	18,808,330
2005	70,116,910	23,313,676	139,665,143	28,901,187
2006	50,544,914	18,943,042	165,394,646	32,980,846
2007	101,601,398	33,758,431	142,114,144	21,466,986
2008	55,307,331	28,386,173	124,265,046	25,554,951
2009	147,618,279	49,856,516	114,400,580	31,694,118
2010	139,308,501	49,260,868	187,344,671	41,340,125
2011	134,256,459	48,738,293	158,129,849	43,846,470
2012	76,334,129	37,030,772	162,739,931	47,336,390
2013	111,068,052	50,473,294	115,623,747	37,420,884
Average	97,706,931	32,087,802	152,399,799	31,721,667

Source: CDFW (2015a).

and surface longlining (potential for space-use conflicts with seismic survey vessels and possible entanglement with thrusters on dynamically positioned drill ships).

Seaweeds, especially kelp, are also commercially harvested within the project area using bow- or stern-mounted cutting mechanisms and conveyor systems (CDFW 2004). Commercial kelp harvesting is regulated by the California Fish and Game Commission through the issuance of licenses. Depending upon the status of the kelp resource within a given year, specific kelp beds may be open or closed to commercial harvesting (CDFW 2014a) and may be open or leased by specific harvesters. From 2004 to 2013, a total of more than 234.4 million pounds of kelp and other seaweeds were harvested within California with a value of more than $185,000.

3.6.2 Recreational Fishing

Southern California is a leading recreational fishing area along the west coast. Weather and sea conditions allow for year-round fishing. Recreational fishing includes hook-and-line fishing from piers and docks, jetties and breakwaters, beaches and banks, private or rental boats, and commercial passenger fishing vessels. Recreational fishing also includes activities such as dive, spear, and net fishing. Recreational fisheries in southern California access both nearshore and offshore areas, targeting both bottom fish and mid-water fish species. Boats can either drift with the currents, anchor, or live-boat to remain on the specific spot. The majority of recreational fishing is done by “jigging” baited hooks or lures. Several hooks or lures often occur on a single weighted line. For pelagic species such as salmon, trolling methods are also used.

The top five recreational landings for the Channel District of California (which includes the majority of the project area) between 2010 and 2014 were barred surfperch, vermilion rockfish, lingcod, bocaccio, and copper rockfish (Table 3-14). The top five recreational landings between 2010 and 2014 for the Southern California District (which extends from Los Angeles County to San Diego) were kelp bass, chub mackerel, California halibut, skate and ray species, and barred sandbass (Table 3-15).

TABLE 3-14 Estimated Total Catch (Metric Tons) of Fish Caught by Marine Recreational Anglers in the California Channel District, 2010–2014[a,b]

	Landing Weights (Metric Tons)						
Species Name	2010	2011	2012	2013	2014	Total	Percent of Total
Barred surfperch	1.09	78.10	87.39	49.65	143.45	359.69	12.6
Vermilion rockfish	26.24	53.65	68.77	69.58	60.15	278.40	9.7
Lingcod	8.73	45.14	60.57	93.56	68.48	276.48	9.7
Bocaccio	16.52	52.30	47.27	53.91	40.99	211.00	7.4
Copper rockfish	18.18	35.75	41.16	61.03	51.87	207.99	7.3
Pacific barracuda	68.82	6.10	36.69	4.13	6.50	122.24	4.3
White seabass	10.36	18.24	28.16	31.09	23.26	111.11	3.9
Bat ray	10.78	9.97	34.89	19.88	15.08	90.60	3.2
California halibut	20.89	16.86	23.67	13.33	13.75	88.49	3.1
Chub (Pacific) mackerel	6.80	33.46	7.81	5.74	26.01	79.82	2.8
Leopard shark	0.66	6.29	25.41	12.15	18.90	63.41	2.2
Pacific sardine	10.43	5.61	25.76	16.41	2.61	60.82	2.1
Pacific sanddab	3.69	15.90	14.00	16.62	7.10	57.30	2.0
Jacksmelt	4.13	8.98	11.00	21.49	8.15	53.74	1.9
Brown rockfish	5.65	10.02	8.77	12.01	12.47	48.92	1.7
California sheephead	4.30	11.35	7.59	6.83	14.81	44.89	1.6
Ocean whitefish	4.33	2.36	14.66	7.74	14.41	43.51	1.5
Kelp bass	3.60	9.83	9.18	7.22	13.12	42.96	1.5
Greenspotted rockfish	6.87	12.29	9.59	4.83	4.90	38.48	1.3
Yellowtail	0.32	1.63	0.38	7.79	28.32	38.45	1.3
Walleye surfperch	4.00	4.13	12.96	5.00	6.00	32.08	1.1
Starry rockfish	4.75	6.12	6.03	6.33	4.05	27.29	1.0

[a] Information for species comprising less than 1% of the total 5-year catch is not shown.

[b] Values derived from the RecFin database (http://www.recfin.org/data/estimates/tabulate-recent-estimates-2004-current) using a query for estimated total catch of fish caught by marine recreational anglers using all modes of fishing in all marine areas in the Channel District from January–December of 2010–2014.

Source: Pacific States Marines Fisheries Commission (2015).

TABLE 3-15 Estimated Total Catch (Metric Tons) of Fish Caught by Marine Recreational Anglers in the California Southern District (Los Angeles to San Diego), 2010–2014[a,b]

Species Name	Landing Weights (Metric Tons)						Percent of Total
	2010	2011	2012	2013	2014	Total	
Kelp bass	205.60	219.76	207.55	263.37	483.37	1379.64	9.9
Chub (Pacific) mackerel	336.92	192.27	194.01	150.69	248.63	1122.51	8.0
California halibut	237.41	89.78	187.06	260.24	144.61	919.10	6.6
Skates and rays[c]	55.23	36.36	260.79	184.73	296.63	833.74	6.0
Barred sandbass	173.50	214.15	158.01	120.91	116.94	783.52	5.6
Yellowtail	39.03	6.11	73.56	70.74	578.77	768.21	5.5
California scorpionfish	97.93	137.42	146.52	152.94	161.75	696.56	5.0
Pacific barracuda	141.79	140.48	95.39	65.50	111.76	554.93	4.0
Bat ray	86.21	31.86	104.18	250.67	60.38	533.30	3.8
Spotted sandbass	127.28	58.41	76.30	98.14	69.84	429.97	3.1
Yellowfin tuna	2.00	—[d]	21.55	0.10	350.27	373.92	2.7
Vermilion rockfish	32.50	64.33	80.40	82.99	70.50	330.72	2.4
Pacific bonito	102.30	4.20	0.96	12.64	199.76	319.86	2.3
Bocaccio	34.34	51.03	76.04	73.92	54.42	289.76	2.1
Pacific sanddab	38.92	65.77	50.08	68.73	62.85	286.36	2.1
White seabass	134.81	26.62	22.02	70.05	29.40	282.90	2.0
Barred surfperch	6.51	32.72	120.24	62.30	30.63	252.39	1.8
California sheephead	35.60	40.74	40.36	65.32	49.58	231.60	1.7
Thresher shark	74.01	79.67	17.49	25.58	10.76	207.51	1.5
Shovelnose guitarfish	36.30	13.46	70.22	28.87	33.48	182.33	1.3
Pacific sardine	46.70	18.34	45.68	56.80	7.48	175.00	1.3
Spotfin croaker	11.91	8.68	54.75	49.13	23.28	147.75	1.1
Rockfish[c]	18.30	22.05	24.31	38.66	41.88	145.19	1.0
Opaleye	46.35	7.52	33.97	17.88	29.35	135.07	1.0

[a] Information for species comprising less than 1% of the total 5-year catch is not shown.

[b] Values are from the RecFin database (http://www.recfin.org/data/estimates/tabulate-recent-estimates-2004–present) using a query for estimated total catch of fish caught by marine recreational anglers using all modes of fishing in all marine areas in the California Southern District from January-December of 2010–2014.

[c] Species not reported.

[d] Annual value not reported.

Source: Pacific States Marines Fisheries Commission (2015).

Private boat fishing, the most popular fishing method, occurs heavily around the Channel Islands and along the coastline off Point Sal on the central coast. Charter and party boat fishing, the most productive method, is heaviest at the Channel Islands and along the Santa Barbara Channel coastline. The most popular fishing grounds for private boat fishing are along the kelp beds within 1 nautical mi of shore, although some fishing areas extend as far as 5 nautical mi from shore (and thus on the OCS) and include lingcod and rockfish grounds over hard bottom areas. Trolling for pelagic species such as salmon, tunas, and billfish species can occur throughout the project area depending on the year and ocean conditions.

A commercial passenger fishing vessel (CPFV) is a boat that is operated by a hired skipper, and on which anglers pay a fee to board and fish. The term CPFV encompasses the terms charter boat (which usually refers to a boat carrying a prearranged, or closed, group of anglers) and party boat (which usually refers to a boat carrying a non-prearranged group). The capacities of CPFVs in the Santa Barbara Channel and central California typically range from six to 50 anglers. Fishing trips normally are for one-half day or a full day; overnight trips are unusual. Private boat fishing encompasses all hook-and-line sport fishing activity from boats other than CPFVs. These vessels are typically 5–8 m long, privately owned, trailered, and launched from ramps for single-day trips.

Estimated angler-days during 2013 for California Fishing District 1 (extends from Los Angeles to San Diego) totaled 532,000, 302,000, and 2,536,000 for recreational party/charter boat, private/rental boat, and shore fishing, respectively (NOAA 2014). The estimated economic benefits to California from District 1 fishing levels totaled approximately $119.4 million, $36.1 million, and $161.7 million for party/charter, private/rental boat, and shore fishing, respectively, and are estimated to have resulted in jobs for approximately 2,950 full- and part-time employees (NOAA 2014). For California Fishing District 2 (Ventura to Santa Barbara, including the Channel Islands), estimated angler-days during 2013 totaled 78,000, 43,000, and 445,000 for recreational party/charter boat, private/rental boat, and shore fishing, respectively (NOAA 2014). The estimated benefits to California from District 2 fishing levels totaled approximately $17.6 million, $5.1 million, and $28.4 million for party/charter, private/rental boat, and shore fishing, respectively, and are estimated to have resulted in jobs for approximately 465 full- and part-time employees (NOAA 2014).

3.7 AREAS OF SPECIAL CONCERN

Areas of special concern, shown in Figure 3-16, are Federally managed areas, also called Marine Protected Areas (MPAs). These include areas designated as national marine sanctuaries (NMSs), NPs, and national wildlife refuges (NWRs). There are also several coastal and aquatic reserves managed by State agencies or nongovernmental organizations along the Pacific coast (BOEMRE 2010). Locations given special designations by Federal and State agencies, such as national estuarine research reserves (NERRs), are also included here. In addition to these types of areas of special concern, the project area also includes offshore military use areas. Critical habitat (as designated under the ESA) for endangered species is discussed in biota-specific subsections of Section 3.5.

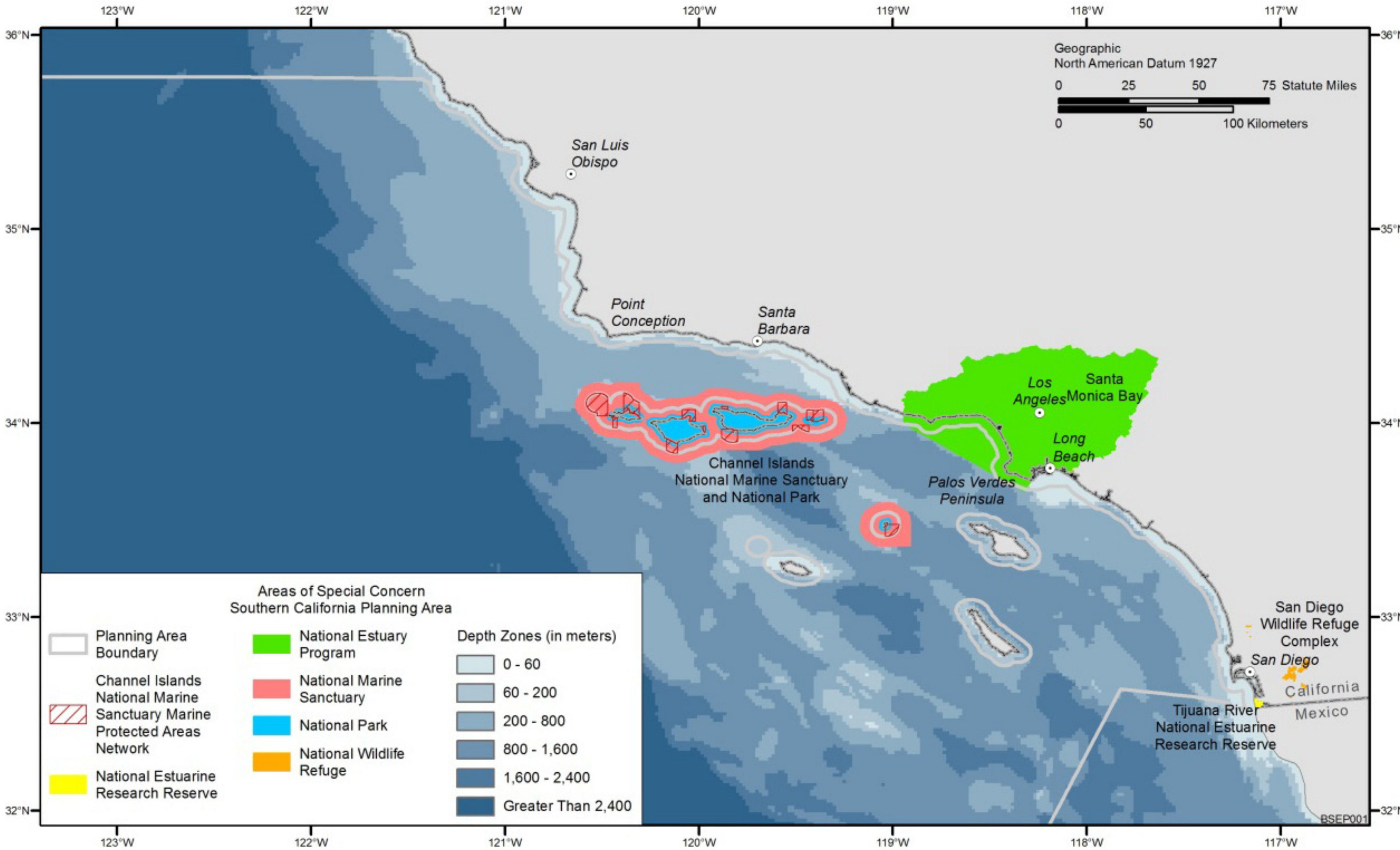

FIGURE 3-16 Areas of Special Concern along the Southern Pacific Coast

3.7.1 Marine Sanctuaries

The only NMS along the southern Pacific coast is the Channel Islands NMS, designated in 1980 under the National Marine Sanctuaries Act (16 U.S.C. 1431 et seq.; U.S. Department of Commerce et al. 2008). The Channel Islands NMS is located in the waters surrounding the islands and offshore rocks in the Santa Barbara Channel: San Miguel Island, Santa Rosa Island, Santa Cruz Island, Anacapa Island, Santa Barbara Island, Richardson Rock, and Castle Rock (Figure 3-16). The sanctuary covers an area of about 1,128 nautical mi^2 and extends seaward about 6 nautical mi from the Channel Islands and offshore rocks.

In 2002, the California Fish and Game established a network of MPAs within the nearshore waters of sanctuary; in 2006 and 2007, NOAA expanded the MPA network into the sanctuary’s deeper waters (National Ocean Service 2015). The entire MPA network consists of 11 marine reserves (where all fish take and harvest is prohibited) and two marine conservation areas (where limited take of lobster and pelagic fish is allowed). The Channel Island NMS supports a diversity of marine life and habitats, unique and productive oceanographic processes and ecosystems, and culturally significant resources such as submerged cultural artifacts and shipwrecks (U.S. Department of Commerce et al. 2008).

3.7.2 National Parks

The Channel Islands NP encompasses an area of over 380 nautical mi^2, including the five islands off the southern coast of California (San Miguel Island, Santa Rosa Island, Santa Cruz Island, Anacapa Island, and Santa Barbara Island) and the seaward waters for a nautical mile beyond the islands. The park has both terrestrial and submerged (aquatic) habitats: kelp forests, seagrass beds, rock reefs, rock canyons, pelagic waters, coastal marshes and lagoons, sand beaches, sea cliffs, and rocky intertidal benches. Ecological resources in the park include seal and seabird rookeries, and at least 26 species of cetaceans have been reported. Archaeological and cultural resources (spanning more than 10,000 years) are also present (BOEMRE 2010).

3.7.3 National Wildlife Refuges

There are 28 NWRs designated as MPAs along the Pacific coast, most of which were established to provide feeding, resting, and wintering areas for migratory waterfowl and shorebirds. Four of these are located off the southern coast of California: (1) Seal Beach, (2) San Diego Bay, (3) San Diego, and (4) Tijuana Slough. Together, these NWRs comprise the San Diego Wildlife Refuge Complex. There are no NWRs directly offshore of Santa Barbara or Ventura Counties (BOEMRE 2010).

3.7.4 National Estuarine Research Reserves

There are six NERRs within the Pacific Region, one of which (the Tijuana River NERR) is located on the southern Pacific coast just to the north of the U.S.–Mexico border. Established in 1982, the Tijuana River NERR is a saline marsh reserve that encompasses 2,500 acres. It is home to eight threatened and endangered species, including the light-footed clapper rail and the California least tern (BOEMRE 2010).

3.7.5 National Estuary Program

Of the six estuaries in the Nation Estuary Program established in the Pacific region, one is located along the southern Pacific coast. The Santa Monica Bay, encompassing nearly 1,500 km^2, was established in 1988 to protect several threatened and endangered species, including the California least tern, western snowy plover, all four sea turtles (green, leatherback, loggerhead, and olive Ridley), and steelhead (BOEMRE 2010).

3.7.6 Military Use Areas

Military use areas, established in numerous areas off all U.S. coastlines, are used by the U.S. Air Force, Navy, Marine Corps, and Special Operations Forces to conduct various testing and training missions. Military activities can be quite varied but normally consist of air-to-air, air-to-surface, and surface-to-surface naval fleet training, submarine and antisubmarine training, and air force exercises. The Point Mugu Sea Range is a region in the southern Pacific region used intensively for military-related operations. The Point Mugu Sea Range encompasses 36,000 nautical mi^2 of ocean and controlled airspace, is about 200 nm long (north to south), and extends west into the Pacific Ocean from its nearest point at the mainland coast (3 nautical mi at Ventura County) out to about 180 nautical mi offshore (Figure 3-17). There are four OCS platforms (Harvest, Hermosa, Hidalgo, and Irene) located in Military Warning Area W-532; these were installed in 1985 and 1986 and are still in place (BOEMRE 2010). Lessees and platform operators are required to coordinate their oil and gas activities with appropriate military operations to prevent potential conflicts with military training and use activities.

The Navy Fleet and Marine Corps amphibious training occurs almost daily along the Pacific coast, with activity varying from unit-level training to full-scale carrier/expeditionary strike group operations and certification.

The U.S. Army Corps of Engineers has established surface danger zones and restricted areas used for a variety of hazardous operations (Figure 3-17) (33 CFR Part 34). The danger zones may be closed to the public on a fulltime or intermittent basis. A restricted area is a defined water area for the purpose of prohibiting or limiting public access. Restricted areas generally provide security for government property and/or protection to the public from the risks of damage or injury arising from the government's use of that area.

3.7.7 California State Protected Areas

There are more than 50 State-designated MPAs along the southern Pacific coast (from Point Conception to the U.S.–Mexico border), covering about 2,351 mi^2 of ocean, estuary, and

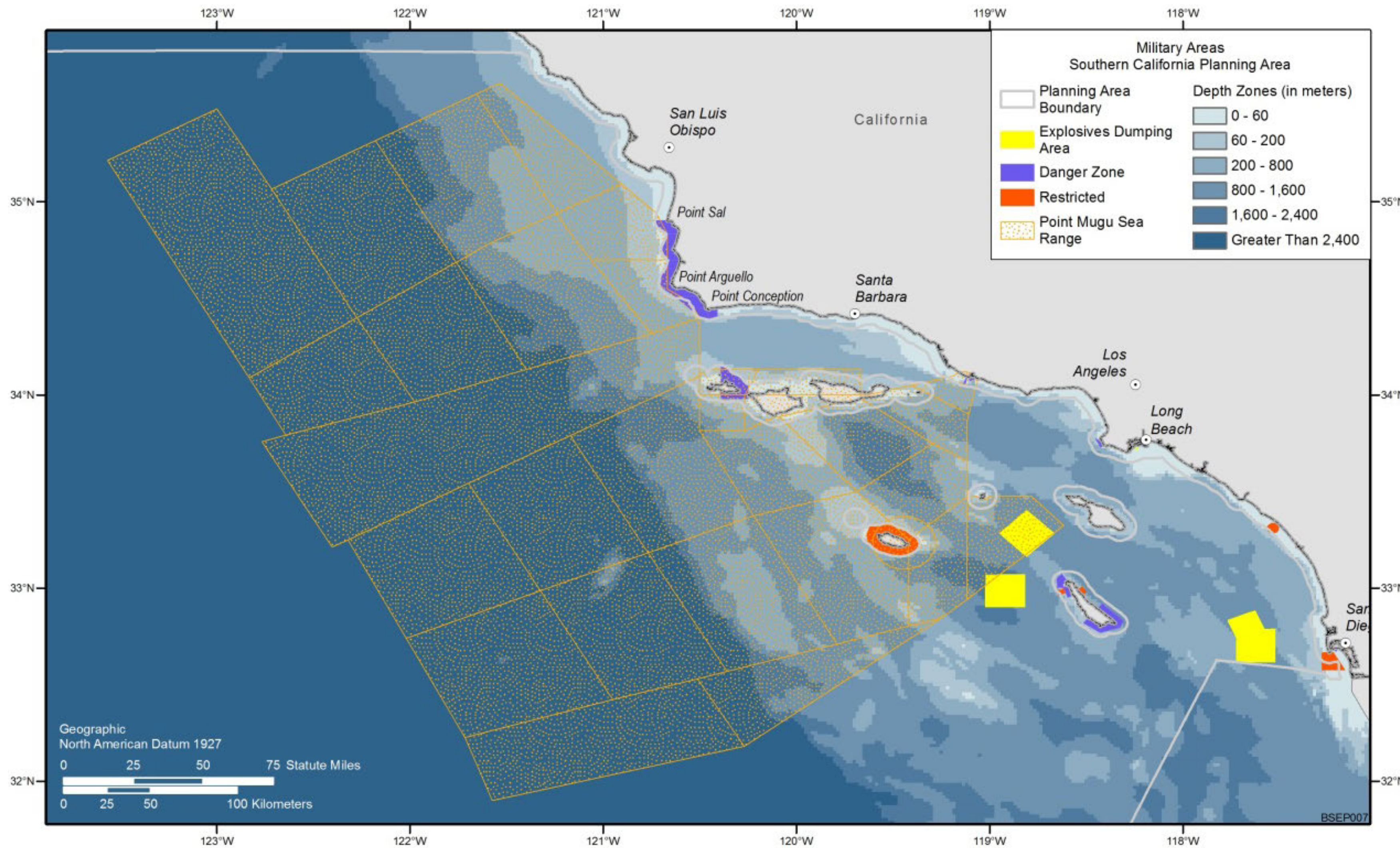

FIGURE 3-17 Military Use Areas along the Southern Pacific Coast

offshore rock/island waters and 356 mi of coastline (Figure 3-18). These designations have been in effect in State waters since January 1, 2012, and include the following:

- 19 State marine reserves, which prohibit damage or take of all marine resources (living, geological, or cultural);

- 21 State marine conservation areas, which allow some recreational and/or commercial take of marine resources;

- 10 State marine conservation areas, which generally prohibit the take of marine resources (living, geological, or cultural), but allow some ongoing permitted activities such as dredging to continue; and

- 2 special closure areas, designated by the California Fish and Game Commission, which prohibit access or restrict boating activities in waters adjacent to seabird rookeries or marine mammal haul-out sites (CDFW 2014b, 2015b).

3.8 ARCHAEOLOGICAL RESOURCES

3.8.1 Regulatory Overview

Section 106 of the National Historic Preservation Act of 1966, as amended (NHPA; 54 U.S.C. 306108) requires that Federal agencies take into account the effect of an undertaking under their jurisdiction on significant cultural resources. A cultural resource is considered significant when it meets the eligibility criteria for listing on the *National Register of Historic Places* (NRHP) (36 CFR 60.4). The Section 106 process requires the identification of cultural resources within the area of potential effect of a Federal project, consideration of a project's impact on cultural resources, and the mitigation of adverse effects on significant cultural resources. The process also requires consultation with State Historic Preservation Officers, the Advisory Council on Historic Preservation, Native American tribes, and interested parties. In the case of oil, gas, and sulfur leases, BSEE and BOEM have established regulations (e.g., 30 CFR 250.194) and issued guidance to lessees (e.g., NTL No. 2006-P03) to ensure compliance with Section 106 of the NHPA and its implementing regulations in 36 CFR Part 800.

3.8.2 Pacific Region

Cultural resources found in the Pacific Region can include submerged prehistoric archaeological sites, shipwrecks, and architectural resources found on the shore. Many of the oldest archaeological sites associated with prehistoric peoples are located on the OCS and were inundated as sea levels rose. Historic resources date to 1542 when Europeans first reached California. The first permanent settlements in the Santa Barbara region began in 1769. Most of

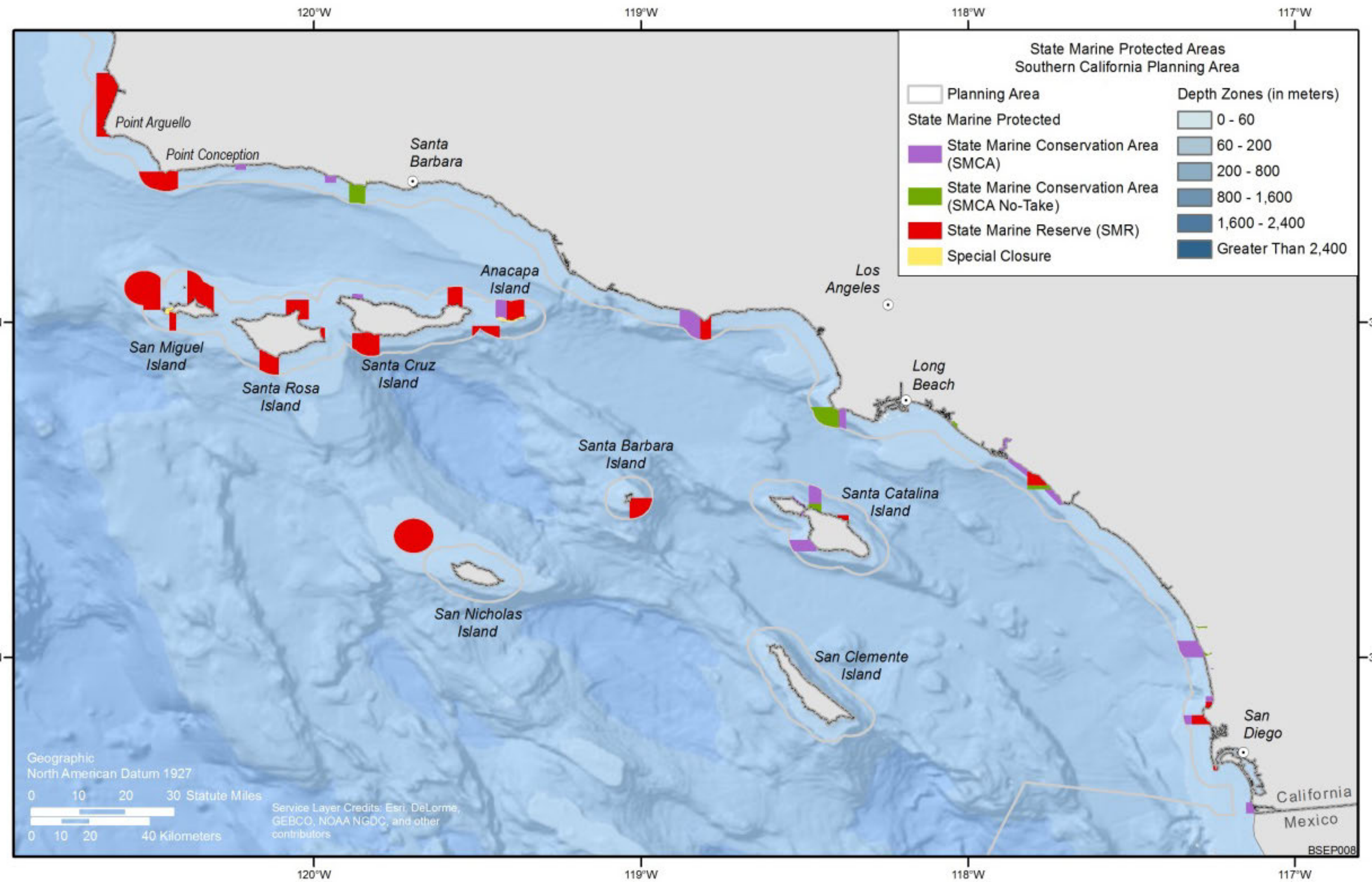

FIGURE 3-18 State-Designated MPAs along the Southern Pacific Coast

the historic resources found on the OCS are shipwrecks. Architectural resources located on the shore consist of buildings and districts associated with American history.

The Santa Barbara Channel Region contains numerous cultural resources (MMS 2005). Past studies indicate that while numerous cultural resources are known in the region, there are likely many more that have yet to be discovered. Only a small percentage of the ships reported lost near the Channel Islands have been located and identified (MMS 2005). Locating inundated archaeological sites is very difficult, and in many cases impossible, because most of the material is below the seafloor. Cultural resources on the seafloor are primarily affected by activities that alter the seafloor, such as platform installation, pipeline installation, and anchor drags.

3.9 RECREATION AND TOURISM

The Pacific coastline is an outstanding natural resource, providing an important recreational asset and contributing to the economic success of the region's tourist industry. Many of its parks, reserves, sanctuaries, and marine protected areas are preferred destinations for residents and visitors. The main recreation and tourism activities in the coastal zone include beach recreation, surfing, sightseeing, diving, and recreational fishing (BOEMRE 2010). Most of these activities occur near established shoreline park, recreation, beach, and public-access sites.

Dean Runyan Associates provides annual analyses of the economic impacts of travel to and through the counties of California. As shown in Table 3-16, visitor spending in the coastal counties of the southern Pacific coast totaled $45.8 billion in 2014.[15] As in previous years, visitor expenditures are concentrated in Los Angeles County ($19.9 billion in 2014) and San Diego County ($13.2 billion in 2014). Travel also results in fiscal impacts in the form of State and local tax revenue. Tax receipts from travel in all the southern coastal counties totaled $4.3 billion in 2014.

Based on data compiled from the U.S. Bureau of Labor Statistics, the NOAA Coastal Services Center (NOEP 2015) estimates employment and wages in the ocean-related sectors in which recreation and tourism occur (Table 3-17). In the southern coastal counties, these wages totaled $4.4 billion in 2012, the most recent year for which data are available. Employment is concentrated in San Diego County (81,200 in 2012) and Los Angeles County (45,400 in 2012). The ocean-related recreation and tourism employment for all coastal counties was 193,000 in 2012.

As indicated by Tables 3-16 and 3-17, tourism is a major economic force for coastal counties along the southern Pacific coast, and any negative changes in tourism would be of major concern. Although few tourism activities are coast-dependent (i.e., cannot occur without access to the coast), the majority are coast-enhanced; it is the coastal orientation of the counties that contributes to the sense of place and the general ambiance so highly valued by visitors to the area.

[15] The estimates for 2014 are considered preliminary (Dean Runyan Associates 2015).

TABLE 3-16 Economic Impacts of Travel in Counties of the Southern Pacific Coast ($ million), 2014

County	Visitor Spending at Destination	Total Direct Tax Receipts (State and Local)
Los Angeles	$19,899	$2,062
Orange	$9,385	$842
San Diego	$13,217	$1,097
Santa Barbara	$1,859	$170
Ventura	$1,403	$127
Total	$45,763	$4,298

Source: Dean Runyan Associates (2015).

TABLE 3-17 Employment and Wages in Ocean-Related Recreation and Tourism Sector in the Southern Coastal Counties, 2012

County	Employment (thousands)	Wages (millions)
Los Angeles	45,440	$1,026.43
Orange	40,081	$935.84
San Diego	81,214	$1,909.28
Santa Barbara	13,231	$287.26
Ventura	13,090	$267.78
Total	193,056	$4,426.59

Source: NOEP (2015).

3.10 ENVIRONMENTAL JUSTICE

E.O. 12898, “Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations” (59 FR 7629) requires Federal agencies to incorporate environmental justice as part of their missions. Specifically, it directs these agencies to address, as appropriate, any disproportionately high and adverse human health or environmental effects of their actions, programs, or policies on minority and low-income populations.

A description of the geographic distribution of minority and low-income groups within the region of influence (ROI) was based on demographic data from the 2014 census estimates (U.S. Census Bureau 2015a–d). The following definitions were used to define minority and low-income population groups:

- **Minority.** Persons are included in the minority category if they identify themselves as belonging to any of the following racial groups: (1) Hispanic; (2) Black (not of Hispanic origin) or African American; (3) American Indian or Alaska Native; (4) Asian; or (5) Native Hawaiian or Other Pacific Islander. Persons may classify themselves as having multiple racial origins (up to six racial groups as the basis of their racial origins).

- **Low-Income.** Individuals who fall below the poverty line are classified as low-income. The poverty line takes into account family size and age of individuals in the family. For any given family below the poverty line, all family members are considered as being below the poverty line for the purposes of the analysis without consideration of individual income variations within the family.

The CEQ (1997) guidance states that low-income and minority populations should be identified where either (1) the low-income or minority population of the affected area exceeds 50%, or (2) the low-income or minority population percentage of the affected area is meaningfully greater than the low-income or minority population percentage in the general population or other appropriate unit of geographic analysis.

Table 3-18 lists the minority and low-income composition within the ROI on the basis of 2010 census data. Although the total minority population (those not listed as white alone) in the ROI exceeds 50%, it not meaningfully greater than that Statewide. The number of persons below the poverty level in the ROI is also comparable to the Statewide level (Table 3-18).

TABLE 3-18 Minority and Low-Income Population Percentage for 2014 within the Region of Influence

Population Category	County				California
	Santa Barbara	Ventura	Los Angeles	Orange	
Black or African American alone	2.4	2.2	9.2	2.1	6.5
American Indian and Alaska Native alone	2.2	1.9	1.5	1.1	1.7
Asian alone	5.7	7.5	14.8	19.6	14.4
Native Hawaiian and other Pacific Islander alone	0.2	0.3	0.4	0.4	0.5
Two or more races	3.5	3.3	2.9	3.3	3.7
Hispanic or Latino	44.4	42.0	48.4	34.3	38.6
White alone, not Hispanic or Latino	45.9	46.6	26.8	42.0	38.5
Persons below poverty level (2009–2013, all races)	16.0	11.1	17.8	12.4	15.8

Sources: U.S. Census Bureau (2015a–d).

3.11 SOCIOECONOMICS

Socioeconomic data are presented for a ROI composed of Santa Barbara, Ventura, Los Angeles, and Orange counties. The ROI captures the area within which any potential impacts of offshore WSTs would be experienced, the area within which workers would spend their wages and salaries, and the expected location of many of the vendors that would supply materials, equipment, and services for the use of the proposed WSTs. The ROI is used to assess the impacts WSTs from each alternative would have on population, employment, income, housing, recreation and tourism, and environmental justice.

3.11.1 Population

In 2014, the estimated population within the four-county ROI was more than 14.5 million people (Table 3-19). The estimated population within the ROI has increased between 2010 and 2014, with the increase over the 5-year time period ranging from 2.8% for Ventura County to 4.5% for Los Angeles County. The Statewide population has increased an estimated 4.2% during this time.

3.11.2 Employment and Income

Table 3-20 presents the average civilian labor force statistics for 2014. For the ROI in 2014, about 6.7 million people in the civilian labor force were employed and more than 543 thousand civilian workers were unemployed. Unemployment rates ranged from 5.5% for Orange County to 8.3% for Los Angeles County (Table 3-20). Employment by industry for 2013 is provided in Table 3-21. For the ROI, only 4,980 (0.09%) of paid employees were part of the mining, quarrying, and oil and gas extraction sector.

TABLE 3-19 Population within the Region of Influence

	Population	
Location	2010	2014 (estimate)
Santa Barbara	423,895	440,668
Ventura	823,318	846,178
Los Angeles	9,818,605	10,116,705
Orange	3,010,232	3,145,515
California	37,253,956	38,802,500

Sources: U.S. Census Bureau (2015a–d).

TABLE 3-20 Average Civilian Labor Force Statistics for 2014

Location	Civilian Labor Force Numbers	Number (Percentage)	
		Employed	Unemployed
Santa Barbara County	218,721	205,421 (93.9)	13,300 (6.1)
Ventura County	431,547	402,720 (93.3)	28,827 (6.7)
Los Angeles County	5,025,883	4,610,795 (91.7)	415,088 (8.3)
Orange County	1,575,606	1,489,164 (94.5)	86,442 (5.5)
California	18,831,395	17,397,119 (92.5)	1,414,276 (7.5)

Source: U.S. Bureau of Labor Statistics (2015).

TABLE 3-21 Paid Employees by Industry within the Region of Influence, 2013

	County					
Sector	Santa Barbara	Ventura	Los Angeles	Orange	ROI Total	Share of ROI Total (%)
Agriculture, forestry, fishing and hunting	723	601	440	187	1,962	0.04
Mining, quarrying, and oil and gas extraction	876	766	2,873	465	4,980	0.09
Utilities	250 to 499	992	10,000 to 24,999	5,000 to 9,999	16,242 to 36,489	0.29 to 0.66
Construction	6,632	12,334	113,059	78,866	210,891	3.79
Manufacturing	13,333	23,031	358,922	149,604	544,890	9.79
Wholesale and retail trade	24,772	52,595	654,906	252,828	985,051	17.70
Transportation and warehousing	2,470	4,971	156,665	24,602	188,708	3.39
Finance, insurance, and real estate	7,415	17,894	240,771	128,410	394,490	7.09
Services	70,855	118,790	1,862,630	618,754	2,671,029	47.99
Other	10,057 to 10,306	15,142	384,566 to 399,565	117,433 to 122,432	527,228 to 547,475	9.47 to 9.84
Total	137,623	247,116	3,799,831	1,381,148	5,565,718	100.00

Source: U.S. Census Bureau (2015e).

Table 3-22 details personal income in the ROI for 2013. Per-capita annual income ranged from $46,530 for Los Angeles County to $54,519 for Orange County, bracketing the Statewide average of $47,434.

3.11.3 Housing

Table 3-23 details the housing characteristics within the ROI. Homeowner vacancy rates within the ROI range from 0.8 to 1.4%, and rental vacancy rates range from 3.3 to 4.2%.

TABLE 3-22 Personal Income (2013 dollars) within the Region of Influence

Location	Total Personal Income	Population	Per-Capita Income
Santa Barbara County	21,725,550	435,697	49,864
Ventura County	42,406,474	839,620	50,507
Los Angeles County	466,098,988	10,017,068	46,530
Orange County	169,792,810	3,114,363	54,519
California	1,856,614,186	38,332,521	48,434

Source: U.S. Bureau of Economic Analysis (2014).

TABLE 3-23 2014 Average Housing Characteristics for the Region of Influence

	Housing Units			Vacancy Rate	
County	Total	Occupied	Vacant	Homeowner	Rental
Santa Barbara	154,414	142,912	11,502	1.4	4.2
Ventura	284,527	269,869	14,658	0.8	3.4
Los Angeles	3,482,681	3,269,112	213,569	1.1	3.3
Orange	1,072,078	1,018,862	53,216	0.8	3.4

Source: U.S. Census Bureau (2015f).

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4 ENVIRONMENTAL CONSEQUENCES

This EA evaluates four alternatives, including a No Action alternative (see Chapter 2). Excluding the No Action alternative, all of the alternatives include the potential use of any of four WSTs at the production platforms currently operating in association with the 43 active leases on the southern California OCS. The locations of the platforms, the active lease areas, and the potentially affected areas associated with the platforms and leases are shown in Figure 4-1. Chapter 3 of this EA describes the nature and condition of resources that occur in the vicinity of the platforms and have the potential to be affected by WST activities on the southern California OCS. Chapter 4 describes the environmental consequences that may occur with implementation of each of the four alternatives; a cumulative impacts analysis is provided at the end of the consequences discussion for each alternative.

The evaluation of environmental consequences presented in this EA focuses on those resources and societal conditions most likely to be affected during WST operations under each of the action alternatives, and on potential impacts that may occur upon the accidental release of WST chemicals and waste fluids or as a result of an accidental seafloor expression of hydrocarbons from a WST application.

4.1 HISTORIC USE OF WSTS IN OFFSHORE WATERS OF SOUTHERN CALIFORNIA

Each of the four WSTs included in the proposed action have been used in California and in Federal and State waters off of southern California (Long et al. 2015a,b). In onshore petroleum production in California, hydraulic fracturing often is used in low-permeability, high-porosity diatomite reservoirs of the Monterey Formation. In comparison, much of the offshore Monterey Formation has been diagenetically altered by burial to a higher density opal-CT[1] and/or quartz. As a consequence of this burial and diagenesis, the porosity of the offshore Monterrey Formation has been significantly lowered, and the resultant higher bulk density allows for greater fracturability of the formation when tectonic stresses are applied. As a result, the offshore reservoirs being produced on the southern California OCS are much more permeable than are onshore reservoirs, and are already highly fractured and brecciated[2] (see Sections 3.2.2.2, 3.2.3.2, and 3.2.4.2). Therefore, little permeability enhancement has been required for their development, and the future use of WSTs is expected to be occasional rather than essential to hydrocarbon production from platforms on the southern California OCS.[3]

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[1] Opal-CT is variety of opal that consists of packed microscopic spheres made up of microcrystalline blades of cristobalite and/or tridymite, with a water content as high as 10% by weight (also known as lussatite).

[2] To be “brecciated” is to be made into breccia, a rock composed of broken fragments of minerals or rock cemented together by a fine-grained matrix.

[3] Some operators have had some success increasing hydrocarbon production by performing frac-pacs (a type of hydraulic fracturing) in the sandstone reservoirs of the eastern Santa Barbara Channel.

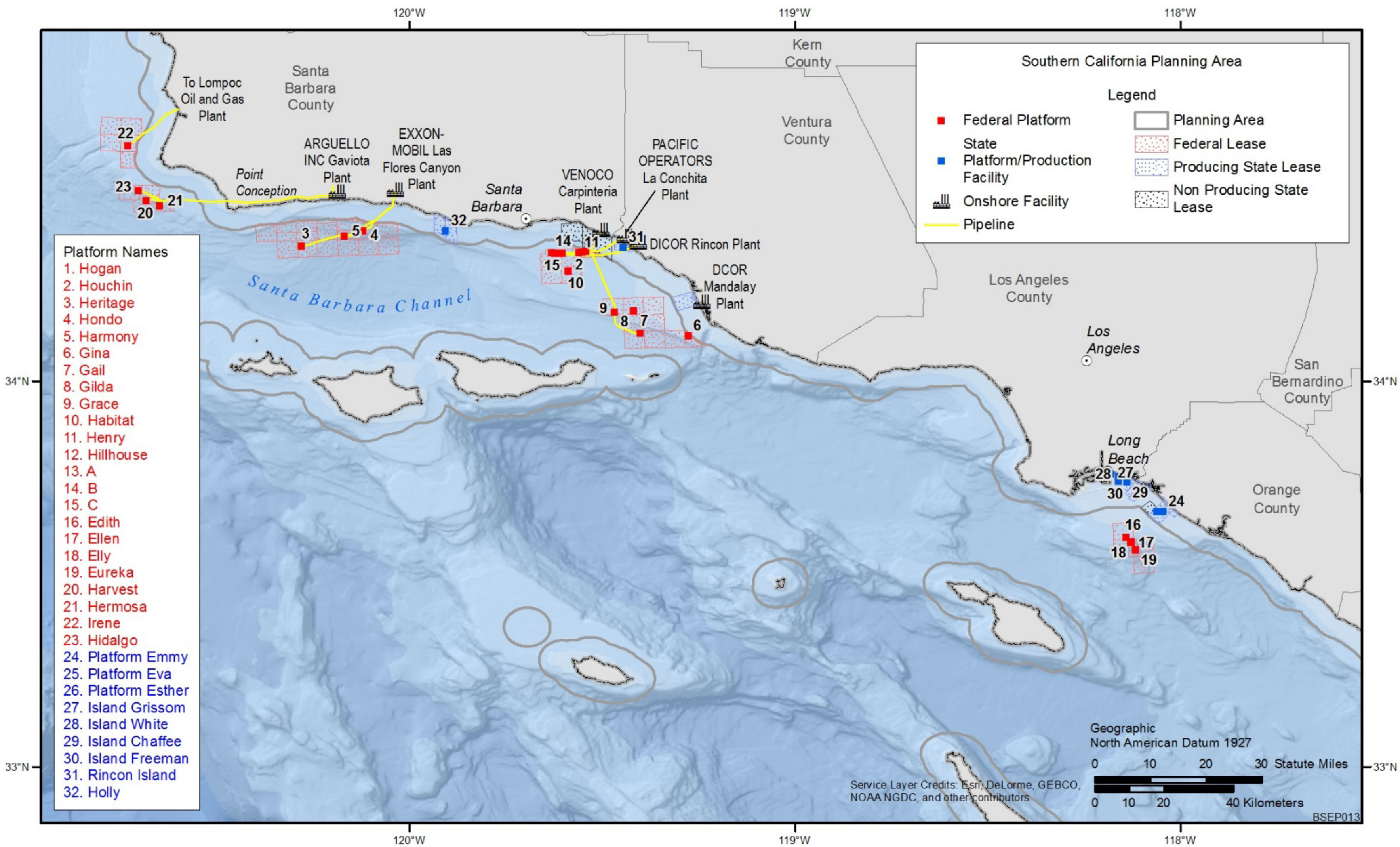

FIGURE 4-1 Locations of Current Lease Areas and Platforms Operating on the Southern California OCS Planning Area (Also shown are platforms and production facilities in offshore State waters adjacent to the Federal OCS. Platforms and lease areas in Federal waters are shown in red, and those in State waters are shown in blue.)

Examination of the available data for offshore hydrocarbon operations of southern California supports this expectation (Houseworth and Stringfellow 2015). For example, more than 1,450 exploration and development wells have been drilled on the southern California OCS. Among these, there have been only 21 hydraulically fractured completions between 1982 and 2014 (two of which were not completed), and these were conducted on only 4 of the 23 platforms in Federal waters on the OCS (Table 4-1) (BOEM 2015a; BSEE 2015a; Houseworth and Stringfellow 2015). Three of these were in the Santa Barbara Channel (Port Hueneme Unit), and the fourth was in the Santa Maria Basin (Port Arguello Unit).

An even smaller number of matrix acidizing treatments may have been conducted in OCS waters during a similar timeframe. The State of California, in its implementation of SB-4, distinguishes between the use of acid for routine well maintenance and for the matrix acidizing WST (which uses acid to increase reservoir permeability).[4] The use of acid for routine well maintenance is common at platforms on the Southern California OCS, while the use of matrix acidizing WSTs is very uncommon. The California Council on Science and Technology recently published an assessment of well stimulation in California, which identified 12 acidizing treatments (at eight different wells) on the Southern California OCS between 1985 and 2011 (see Table 2.5.3 in Houseworth and Stringfellow 2015). BSEE examined this list and was able to confirm the classification of only two of these treatments as meeting the SB-4 definition for matrix acidizing[5] plus one of undetermined classification because the volumes of acids used were not listed in the associated permit (Table 4.1). The rest would be currently classified as routine well maintenance treatments.

In comparison to past use of WSTs on the Federal OCS, there has been greater use of WSTs in State waters, although WST use is still small compared to the number of wells present in State waters. For example, there are 1,972 active or idled offshore wells in southern California State waters (DOGGR 2015; Houseworth and Stringfellow 2015). Between January 2002 and December 2013, there were 117 hydraulic fracture treatments in State waters, with most (106) conducted at production facilities on the THUMS[6] islands in San Pedro Bay off of Long Beach, California (Houseworth and Stringfellow 2015). Similarly, between June 2013 and April 2014, there were 135 acid treatments (which included both matrix acidizing [a WST] and well cleanout [as part of routine oil and gas operations]) reported from State waters in the Los Angeles Basin, with the majority of these (111) occurring on the THUMS Islands.

4.2 WST OPERATIONS AND IMPACTING FACTORS

The application of any of the WSTs included in the proposed action follows three basic steps: (1) the delivery of WST materials (i.e., WST fluids and chemicals) to a platform; (2) the

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[4] This EA follows the definition of matrix acidizing as defined in SB-4, approved September 2013. Historic operations on the OCS employing acids have been interpreted as being either matrix acidizing WSTs or routine acid treatments (e.g., acid wash, Section 2.2.4.1).

[5] For this examination, BSEE used the California DOGGR Acid Volume Threshold calculation methodology to differentiate matrix acidizing treatments from wellbore maintenance operations that use acid (acid wash). The methodology is available from the California DOGGR at http://www.conservation.ca.gov/dog/for_operators.

[6] THUMS is the name used for five artificial islands in the vicinity of Huntington Beach and Long Beach, after the Texaco, Humble, Union, Mobil, and Shell oil companies that initially developed the islands.

TABLE 4-1 WST Applications on the Southern California OCS

Date	Platform/Well	Formation/Field	Operator
Hydraulic Fracturing			
1982	Grace/A-4	Monterey	Chevron U.S.A.
1983	Grace/A-21	Upper Repetto	Chevron U.S.A.
1984	Grace/A-3	Monterey	Chevron U.S.A.
1984	Grace/A-16	Monterey	Chevron U.S.A.
1986	Gilda/S-59	Monterey	Union Oil Co. of California
1994	Gilda/S-60	Upper Repetto	Union Oil Co. of California
1996	Gilda/S-89	Upper Repetto	Torch Operating Co.
1996	Gilda/S-62	Upper Repetto	Torch Operating Co.
1996	Gilda/S-89	Upper Repetto	Torch Operating Co.
1997	Gilda/S-87	Upper Repetto	Torch Operating Co.
1997	Hidalgo/C-1	Monterey	Chevron U.S.A.
1997	Hidalgo/C-11	Monterey	Chevron U.S.A.
1997	Gilda/S-62	Lower Repetto	Torch Operating Co.
1998	Gilda/S-28	Lower Repetto	Nuevo Energy
1998	Gilda/S-61	Lower Repetto	Nuevo Energy
2001	Gilda/S-65	Lower Repetto	Nuevo Energy
2001	Gilda/S-44	Lower Repetto	Nuevo Energy
2001	Gilda/S-62	Lower Repetto	Nuevo Energy
2010	Gail/E-8	Monterey	Venoco, Inc.
2014	Gilda/S-75	Upper Repetto	DCOR
2014	Gilda/S-33	Upper Repetto	DCOR
Matrix Acidizing			
1985	Gilda/S-44[a]	Santa Clara	Union Oil Co. of California
1988	Gilda/S-44[a]	Santa Clara	Union Oil Co. of California
1992	Gail/E-11[a]	Upper Sespe	Chevron U.S.A.

[a] Underwent matrix acidizing as defined under SB-4.

Sources: BSEE (2015a); Houseworth and Stringfellow (2015).

injection of WST fluids into the well undergoing treatment; and (3) the collection, handling, and disposal of WST-related waste fluids. It is important to note that implementation of any of the WSTs included in the proposed action would largely use existing infrastructure, would require no construction of new infrastructure (e.g., no new pipelines, no new platforms), and would not result in bottom-disturbing activities (e.g., trenching). Implementation would occur using existing infrastructure, with the possible exception of some minor equipment changes that would not entail any seafloor disturbance (e.g., replacement of existing platform injection pumps or fluid storage tanks with higher capacity equipment). New equipment may include blending units for mixing the injection fluid, additives, and proppant; and piping (the manifold) for connecting the injection pump and blender to a wellhead. Even with any such changes, no bottom disturbance would occur at the platforms. The following sections present the assumptions that were used regarding WST applications in this EA for identifying and evaluating potential environmental consequences of the proposed action and alternatives.

4.2.1 Delivery of WST Materials

The primary materials that are used by the WSTs included in the proposed action are base fluids (such as acid solutions), proppant (such as sand), and any chemical additives (such as biocides and corrosion inhibitors). Platforms on the southern California OCS are serviced by regularly scheduled platform service vessels (PSVs) that bring materials and supplies (such as diesel oil, food, paints, and cleaning supplies) and personnel to and from the platforms. For a WST, additional PSVs and/or trips would be needed to bring required WST-related materials to a platform. These additional trips (up to six for equipment delivery and four for WST materials delivery) represent a short-term, localized, and minor increase in PSV traffic over levels that currently occur in support of oil and gas production activities at the platforms. During delivery, all WST-related fluids and chemicals (e.g., acids, proppant, and biocides) would be transported in shipping containers designed and certified for marine and offshore transport. For example, bulk liquids would be transported in 350-gal or 500-gal stainless steel totes and non-liquid materials (e.g., proppant) would be transported in appropriate steel transport pods, all designed for marine transport and in compliance with U.S. Department of Transportation and International Maritime Dangerous Goods Code shipping requirements as identified on the Material Safety Data Sheets (MSDS) for each material being transported. All transport of WST-related materials to the OCS platforms would also be done in full compliance with all appropriate U.S. Coast Guard and BSEE shipping and safety requirements.

4.2.2 WST Implementation and Operation

During a WST, chemical additives (e.g., biocides, surfactants) or proppant are mixed into a base injection fluid, filtered seawater. The seawater is sourced at each platform using seawater pumps that are present on each platform and that provide the platform with routine water needs, such as cooling water, firefighting water, and wash-down water. For each WST, the appropriate fluid is injected under the specific pressure, volume, and duration needed for the particular WST application (e.g., 4,200 gal [100 bbl] for a data-frac; 60,000 gallons per stage for a hydraulic fracture treatment) as specified in the APD or APM. Pumping time will vary by the type of WST being conducted and the number of stages needed for completion. For a DFIT, pumping time may be less than 10 minutes, while the pumping time for a hydraulic fracturing treatment may be as much as 4 hr per stage.

4.2.3 WST Waste Handling and Disposal

Well stimulation treatment operations produce waste fluids containing WST-related chemicals recovered during production, and air emissions associated with the operation of WST-related equipment (e.g., injection pumps, blending units) and with the transport of WST materials and supplies to and from platforms (e.g., PSV traffic). Following completion of a WST, waste fluids containing WST-related chemicals may be collected and disposed of in a manner similar to that for produced water during routine (non-WST) oil and gas production. Hydrocarbon reservoirs generally contain naturally occurring water (the formation water) along with oil and natural gas. During hydrocarbon production (whether offshore or onshore and regardless of recovery method), water from within the formation is recovered comingled with the recovered hydrocarbons. Typically, the percentage of this comingled produced water increases as the reservoir hydrocarbons are depleted. On the southern California OCS, hydrocarbon production is accompanied by a considerable amount of produced water. For example, annual produced water at Platform Gilda between 2009 and 2013 averaged about 54.6 million gal (1.3 million bbl) (BSEE 2015b). In 2014, approximately 5.3 billion gal (125 million bbl) of water were produced from 400 oil-producing wells on the southern California OCS, together with about 776 million gal (18.5 million bbl) of oil, for a water-to-oil ratio of about 6.8:1 (BSEE 2015b).

On the southern California OCS, the hydrocarbon/water emulsion ("wet oil") produced at a well is treated to separate the hydrocarbons from the produced water, either on a platform or at an onshore facility. Based on their locations and groupings, some of the OCS platforms are connected to one another by pipelines; others are also connected by pipelines to onshore facilities, and wet oil from several wells and platforms may be combined prior to processing. For example, the wet oil from Platforms Houchin and Hogan is combined at Platform Hogan and transported via pipeline to an onshore processing facility at La Conchita, where the produced water is separated and sent back to the platforms for disposal (Houseworth and Stringfellow 2015). With platform separation, the produced water is disposed of either by reinjection into the reservoir, or by discharge to the ocean under the NPDES General Permit CAG280000.[7] With onshore separation, the produced water is either disposed of by onshore injection to a reservoir, or piped back to the platforms for disposal by injection or NPDES-permitted discharge (Houseworth and Stringfellow 2015).

During the process of a WST, waste fluids (e.g., the flowback) would be comingled with the recovered wet oil. In general, the wet oil/WST waste fluid mixture undergoes oil/water separation and the WST waste fluids become part of the produced-water waste stream following separation. In some cases, the flowback may be collected separately and disposed of onshore. Table 4-2 details the transport of produced water to and from each platform on the southern California OCS, as well as the nature of produced water disposal at each platform.

4.2.4 Impacting Factors Associated with WST Use

For each of the three steps involving WST material and fluid handling (material delivery; injection; and waste fluid collection, processing, and disposal), impacting factors were identified that have the potential to affect one or more natural, cultural, or socioeconomic resources in the area of the southern California OCS. The WST-related impacting factors, the potentially affected resources, and the associated potential effects that were evaluated in this EA are presented in Table 4-3.

[7] As noted in Chapter 3, discharges from offshore oil and gas platforms on the southern California OCS are currently regulated under NPDES General Permit CAG280000, issued by EPA Region 9 effective March 1, 2014, and expiring on February 28, 2019 (EPA 2013a). The EPA uses General Permits to streamline the permitting process for facilities that are anticipated to discharge within the limits of the permit and thereby not significantly affect marine environments.

1 **TABLE 4-2 Hydrocarbon/Produced Water Separation and Produced Water Disposal on Platforms**
2 **on the Southern California OCS**

Platform	Produced Water Transport	Produced Water Disposal[a]
Tranquillon Ridge Field		
Irene	Sends wet oil[b] to onshore facility at Lompoc; receives treated produced water from the Lompoc facility.	Onshore and offshore injection.[c]
Pitas Point Field		
Habitat	No wet oil or produced water transport to or from the platform.	Permitted discharge under NPDES General Permit CAG280000.
Dos Cuadras Field		
Hillhouse	Receives wet oil from Platform Henry.	Permitted discharge under NPDES General Permit CAG280000.
A	Receives produced water from Platform B; sends produced water to onshore facility at Rincon. Receives treated produced water from Rincon onshore facility via Platform B.	Permitted discharge under NPDES General Permit CAG280000.
B	Sends produced water to Rincon via Platform A; receives treated produced water from Rincon onshore facility.	Permitted discharge under NPDES General Permit CAG280000.
C	Sends wet oil to Rincon via Platform B; receives treated produced water from Rincon via Platform B.	No direct discharge from Platform C; injects some produced water.
Carpinteria Offshore		
Hogan	Receives wet oil from Platform Houchin and sends wet oil to onshore processing facility at La Conchita; receives treated produced water from La Conchita and sends some produced water to Platform Houchin.	Permitted discharge under NPDES General Permit CAG280000; may be combined with treated produced water from onshore facility at La Conchita.
Houchin	Sends wet oil to Platform Hogan; no transport from platform; receives some produced water from Platform Hogan.	No direct discharge at Platform Houchin; injects some produced water.
Henry	Sends wet oil to Platform Hillhouse for separation and discharge of produced water; no transport of produced water to or from other platforms.	No direct discharge at Platform Henry.
Sockeye Field		
Gail	No transport of produced water to or from platform; receives wet oil from Platform Grace.	Injects all produced water.

3

TABLE 4-2 (Cont.)

Platform	Produced Water Transport	Produced Water Disposal[a]
Santa Clara Field		
Gilda	Sends wet oil to onshore facility at Mandalay; receives treated produced water from the Mandalay facility.	Permitted discharge at Platform Gilda under NPDES General Permit CAG280000 includes treated produced water from Platform Gina following onshore processing at the Mandalay facility.
Grace	No transport of produced water to or from platform; sends wet oil to Platform Gail.	No direct discharge at Platform Grace..
Hueneme Field		
Gina	Sends wet oil to Mandalay facility.	No direct discharge at Platform Gina; treated produced water disposed of at Platform Gilda (via Mandalay facility).
Point Arguello Field		
Hermosa	Receives wet oil from Platforms Hidalgo and Harvest; sends combined wet oil to onshore facility at Gaviota; some remains at the platform; no transport between platforms.	Some permitted discharge under NPDES General Permit CAG280000 at platform, some onshore injection at the Gaviota facility.
Hidalgo	Sends wet oil to Platform Hermosa; some produced water remains at the platform.	Some permitted discharge at Platform Hidalgo under General Permit CAG280000, some onshore injection at the Gaviota facility (via Platform Hermosa).
Harvest	Sends wet oil to Platform Hermosa; some remains at the platform.	Some permitted discharge at Platform Harvest under NPDES General Permit CAG280000; some onshore injection at the Gaviota facility (via Platform Hermosa).
Hondo Field		
Hondo	Sends wet oil to Platform Harmony.	No direct discharge at Platform Hondo; produced water discharged at Platform Harmony.
Harmony	Receives wet oil from Platforms Hondo and Heritage; sends combined wet oil to onshore facility at Las Flores Canyon; receives treated produced water from the Las Flores Canyon facility.	Permitted discharge of produced water under General Permit CAG280000 from Platforms Hondo and Heritage (via the Las Flores Canyon facility).
Pescado Field		
Heritage	Sends wet oil to Platform Harmony.	No direct discharge at Platform Heritage; produced water discharged at Platform Harmony.

TABLE 4-2 (Cont.)

Platform	Produced Water Transport	Produced Water Disposal[a]
Beta Field		
Eureka	Sends wet oil to Platform Elly for processing[d]; no produced water transport from platform; receives produced water from Platform Elly.	No direct discharge at Platform Eureka; injects all produced water (including water returned from Platform Elly).
Edith	No transport of produced water from platform.	Permitted discharge at Platform Edith of produced water under General Permit CAG280000; also some injection.
Ellen	Sends wet oil to Platform Elly for processing; receives produced water from Platform Elly.	No direct discharge at Platform Ellen; produced water injected
Elly	Receives wet oil for processing from Platforms Eureka and Ellen; sends produced water to Platforms Ellen and Eureka.	No routine discharge; all produced water returned to Platforms Ellen and Eureka for injection.

[a] Open water discharge is permitted from all platforms on the southern California OCS under NPDES General Permit CAG280000, although not all platforms conduct open water discharge.

[b] “Wet oil” refers to the emulsion of crude oil and produced (formation) water produced at a well. This mixture is then processed to separate the oil and produced water.

[c] The term “injection” does not differentiate between disposal and use at any particular platform. For example, produced water may be injected solely for disposal purposes, or for formation pressure maintenance purposes.

[d] Platform Elly is a processing-only platform.

Source: BSEE and BOEM (2014).

4.3 WST-RELATED ACCIDENT SCENARIOS

There have been no reported releases of WST chemicals or fluids on the southern California OCS (Houseworth and Stringfellow 2015), but accidental releases may occur during (1) the transport of WST chemicals and fluids to platforms; (2) WST fluid injection; and (3) the handling, transport, treatment, and disposal of WST-related waste fluids. Some accident scenarios may be applicable to each of the four WSTs included in the proposed action, while other scenarios are applicable to only some of the WSTs (i.e., only with fracturing WSTs).

The primary concern associated with a WST-related accident is the release of WST chemicals, fluids, and waste fluids (and in some accident scenarios, crude oil), and the potential effect of any such releases on exposed resources. The nature, duration, and magnitude of any resultant effects on exposed resources will depend on the location, nature, magnitude, and duration of the accidental release and the resources affected. For a resource to be adversely affected, it must be exposed to the WST-related chemicals at both a concentration and duration that could result in an adverse effect.

TABLE 4-3 WST Activities, Associated Impacting Factors, and Potential Effects Included for Analysis in This EA

WST Activity and Associated Impacting Factor	Potentially Affected Resource	Potential Effects Included for Analysis
Delivery of WST Supplies		
Transport of WST materials and supplies to the platforms	Air quality	Air emissions from WST-related PSV traffic and from onshore truck traffic delivering WST-related supplies to PSV port may reduce local air quality.
	Sea turtles and marine mammals	Injury or mortality from ship strikes with WST-related PSV traffic.
Implementation of WST		
WST fluid injection	Air quality	Air emissions from WST equipment at the platform may reduce local air quality.
	Geology/seismicity	Induced seismicity (earthquakes) with fracturing WSTs.
WST Waste Fluid Collection, Processing, and Disposal		
Injection of WST waste fluids	Geology/seismicity	Induced seismicity (earthquakes) with fracturing WSTs.
Permitted discharge of produced water containing WST waste fluids	Water quality	Localized reduction in water quality.
	Benthic resources, marine and coastal fish and EFH, sea turtles, marine and coastal birds, marine mammals	Localized exposure to potentially toxic levels of WST-related chemicals; loss of prey similarly exposed; reduced habitat quality in the vicinity of platforms discharging WST-related fluids.
	Areas of special concern, recreation and tourism	Localized decrease in water quality may affect natural resources and use of affected areas.
	Commercial and recreational fisheries	Localized reduction in abundance (catch) of fishery resources due to exposure to and effects of potentially toxic levels of WST-related chemicals.
	Environmental justice	Localized decrease in water quality could affect subsistence resources in, or reduce access to, recreational areas by low-income and minority populations.
	Socioeconomics	Localized decrease in water quality could reduce levels of commercial or recreational fishing, as well as other recreation and tourism activities.

Because WSTs on the OCS would be conducted in accordance with all BSEE, BOEM, and other regulatory agency rules and regulations dealing with safety and spill response, the potential for an accidental release to occur is low in all the accident scenarios considered in this EA. All APDs and APMs related to WST use would be fully reviewed for safety concerns before any approval to proceed would be granted.[8] Each of the OCS platforms has systems in place to mitigate spills on the drill deck that may reach the ocean (Aspen Environmental Group 2015). In addition, required monitoring would act to maintain control over WST operations.

4.3.1 Accidents during Transport and Delivery of WST Chemicals and Fluids

An accidental release of WST chemicals could occur with any of the four WST types during the delivery of required materials and their subsequent offloading to a platform (Table 4-4). With a given application of a given WST type, required chemicals would be delivered to a platform via a PSV. They would be transported in sealed steel containers designed for marine transport and in compliance with U.S. Department of Transportation, International Maritime Dangerous Goods code,[9] U.S. Coast Guard, and BSEE packaging and shipping requirements. Although the loss of individual shipping containers is not uncommon in maritime transport, such an incident on a PSV would not by itself result in the release of any WST chemicals. For a release to occur, the accident would have to include a loss of integrity of one or more shipping containers. Short of a major collision with another surface vessel or a platform, such an event is not considered to be likely in the foreseeable future. Collision accidents involving commercial vessels, and especially PSVs, are very uncommon on the southern California OCS. For example, the Ports of Los Angeles and Long Beach share common entry and exit shipping lanes. Together they experience over 5,000 vessel calls each year, yet have averaged 28 reported vessel incidents each year between 2011 and 2013 (Harbor Safety Committee 2014). Of these incidents (involving all ship types, e.g., container and bulk ships), the majority were associated with propulsion issues rather than with collisions. The U.S. Coast Guard lists only two maritime incident reports involving offshore supply vessel collisions for the southern California coast between October 1, 2010, and October 1, 2015. One occurred in San Diego Harbor, where the supply vessel was backing out away from a pier and collided with a

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[8] When an APD or APM containing WST operations is received in the BSEE Pacific OCS Regional Office, it is reviewed by BSEE California District Office Well Operations Section engineers to determine compliance. The required APM/APM District Production Engineering, BOP Control System Drawing, and Hydraulic Fracturing Engineering Data reviews are conducted and documented in the eWell data system. Concurrently, BSEE staff in the Regional Office of Production and Development (OPD) review the APD/APM for conservation of oil and gas resources as well as for potential geohazards. If the APD or APM is for a hydraulic fracture operation, OPD will also look at the proposed fracture in relation to active faults and the location of other wellbores, staying at least 1000 ft away from either. The OPD then documents the Geologic Review in eWell. Environmental Compliance personnel from the BSEE California District Office review the existing NEPA analysis, tiering from the relevant production plan and drilling permit, to determine whether it is adequate for the APD or APM, or whether additional NEPA analyses/findings are needed. Once completed, the review and resulting information is also documented in eWell. Upon completion of all of the above-mentioned reviews, and provided the information is compliant with all applicable standards and regulations, the District approves the permit in eWell.

[9] The International Maritime Dangerous Goods code provides international guidelines for the safe transport or shipment of dangerous goods.

TABLE 4-4 Potential Accident Events during Transport and Delivery of WST Chemicals and Fluids

WST Activity	Nature of Accident Event	Applicability	Anticipated Likelihood of Occurrence
Transport and delivery of WST chemicals to platforms	Release of relatively small quantities of WST chemicals from PSVs following loss of transport container integrity	Applicable to all four WST types	Anticipated likelihood: very low probability and not reasonably foreseeable. All WST chemicals would be transported on PSVs in approved shipping containers and transported in compliance with appropriate BSEE and U.S. Coast Guard shipping and safety regulations and requirements. Even with loss of a container overboard, because the transport containers would be sealed, release of chemicals would only occur with rupture of the shipping container.
	Release of relatively small quantities of WST chemicals during crane transfer from PSV to platform storage	Applicable to all four WST types	Anticipated likelihood: low probability but reasonably foreseeable. The transfer by crane of WST chemicals would be conducted in compliance with appropriate BSEE and U.S. Coast Guard safety regulations and requirements. For a release to occur, the accident would have to result in the rupture of the transport container.

moored vessel, causing minor damage to its hull. The second collision occurred near Long Beach and resulted in minor damage to a lifeboat on the PSV (USCG 2015). Considering the very low number of incidents (about 30/yr) that occur at the Ports of Los Angeles and Long Beach (the latter of which is the second busiest port in the United States) compared to the total vessel traffic using these ports (in excess of 5,000/yr), a collision accident involving a WST-related PSV is not considered likely or reasonably foreseeable.

In contrast, there is a greater but still low likelihood of an accidental release of WST chemicals while a crane is offloading shipping containers from a PSV to a platform. Platform accidents involving cranes do occur during non-WST operations (i.e., routine oil and gas operations) on the platforms. For example, between 2005 and 2015 there were 127 crane incidents reported from platforms on the Pacific OCS (Kaiser 2015). A release of WST chemicals could occur if a shipping container is dropped during offloading, comes in contact with the platform or the PSV, ruptures, and releases its contents. Such an accident would likely involve no more than a few containers at any one time (based on the capacity of the crane and the number and size of transport containers being offloaded). This would limit the volume of materials accidentally released. For example, the U.S. Coast Guard reported the drop of a marine portable tank containing a 15% HCl solution onto the deck of a PSV at Platform Hondo on

March 5, 2014 (USCG 2015). The tank was dropped when the crane failed—in this accident the tank was damaged—but there was no release of its contents. Depending on the location of the release, the rapid implementation of spill control measures on the platform and the PSV would further limit the amount of the release that would reach the ocean. This accident scenario is considered reasonably foreseeable.

Should there be an accidental release of WST chemicals during transport and delivery to a platform, a variety of resources could be affected (Table 4-5). The nature and magnitude of any effects on these resources will be dependent on the location, nature, magnitude, and duration of the accidental release, on the materials released, and on the resources exposed.

4.3.2 Accidents during WST Fluid Injection

During WST fluid injection, the accidental release of WST-related chemicals could occur in a number of ways, although most are considered highly unlikely and not reasonably foreseeable (Table 4-6). For each of the four WSTs included in the proposed action, accidental releases of WST chemicals during implementation could occur as a result of equipment malfunction on the platform during fluid blending and injection. For the fracturing WSTs, which inject fluids at pressures exceeding the formation fracture pressure, accidental releases of WST chemicals may occur via a seafloor surface expression as a result of well casing failure during injection, or if a resultant fracture contacts an existing pathway (such as a fault or existing well) to the seafloor.

Equipment malfunctions on platforms do occur. Malfunctions of blending units, injection pumps, manifolds, and other platform equipment could release small quantities of WST

TABLE 4-5 Impacting Factors for Potential Accident Events during Transport and Delivery of WST Chemicals and Fluids

Accident Event—Impacting Factor	Resource	Potential Effect Evaluated
WST fluid release during delivery, offloading, platform storage	Air and water quality	Localized temporary reductions in air and water quality.
	Benthic resources, marine and coastal fish and EFH, sea turtles, marine and coastal birds, marine mammals	Localized lethal or sublethal effects with exposure to potentially toxic levels of WST-related chemicals; localized, temporary reduction in habitat quality.
	Commercial and recreational fisheries	Localized and temporary closure of fisheries due to health concerns. Reduction in abundance of fishing resources (i.e., fish/invertebrates) due to effects of exposure to toxic levels of WST-related chemicals.

TABLE 4-6 Potential Accident Events during WST Fluid Injection

WST Activity	Nature of Accident Event	Applicability	Anticipated Likelihood of Occurrence
WST-related platform operations (e.g., WST fluid injection)	Release of WST chemicals following malfunction of platform equipment (e.g., injection pumps, blenders). Applicable to all WSTs	Applicable to all four WST types	Anticipated likelihood: low probability and reasonably foreseeable. Relatively small, short-term releases may occur with malfunction of blending and injection equipment.
	Seafloor surface expression of WST fluids, produced water, and hydrocarbons during injection due to a well casing failure	Applicable only to fracturing WSTs	Anticipated likelihood: very low probability and not reasonably foreseeable. Real-time pressure monitoring during WST implementation would identify a decrease in pressure associated with a casing failure, and result in immediate cessation of WST fluid injection. Casing design requirements further reduce likelihood of such an event during WST use.
	Seafloor surface expression of WST fluids, produced water, and hydrocarbons following contact of new fracture with an existing pathway (e.g., fault or well) to the seafloor	Applicable only to fracturing WSTs	Anticipated likelihood: very low probability and not reasonably foreseeable. Real-time pressure monitoring during WST implementation would identify potential contact with an existing fault, fracture, or well and would result in immediate cessation of WST. Existing low reservoir pressures, together with pressure from overlying rock and seawater, would greatly limit the potential for, and the volume of, a surface expression should contact occur with an existing seafloor pathway.

chemicals and result in a surface spill. Any such malfunctions would tend to be quickly detected and WST activities halted, and any releases would be quickly addressed through implementation of existing spill containment and cleanup measures. Thus, although such accidental releases may occur, they would likely result in the release of only small quantities of WST chemicals that may or may not reach the open ocean. This accident scenario is considered to have a low probability of occurrence but is still reasonably foreseeable.

During fracturing WSTs, fracturing fluids are injected at pressures that exceed the formation fracture pressure, and held at that pressure for a time. It is possible that for wells that undergo repeated fracturing WSTs, the well cement casing could fail after repeated pressurization and depressurization events. In such a scenario, the cement bond between the well casing and the formation fails after repeated application of fracturing pressures, thus providing a pathway for well fluids to pass along the outside of the well casing, migrate upward, and be released from the seafloor. All downhole wellbore operations must use pressure-tested lines and tubing, and casing that is rated (with a safety factor usually 70%) to handle the planned pressures of the operation and comply with BSEE regulations (see 30 CFR 250 subpart D, Oil and Gas Drilling Operations). In addition, injection pressures must always be within BSEE regulations (as all wellbore operations must be, not just those unique to fracturing operations). Finally, given the past limited WST use on the Pacific OCS (see Table 4-1), and the likely limited future application of fracturing WSTs, few if any wells may be expected to undergo sufficient repeated pressurization and depressurization events to affect well cement casing integrity. Such an accident scenario, while possible, is considered to have a very low probability of occurrence and is not reasonably foreseeable.

An accidental release of WST chemicals may also occur during a fracturing WST if a new fracture contacts an existing pathway (such as an existing fault or another well) to the seafloor. Such an occurrence could result in the accidental release of WST chemicals, hydrocarbons, and produced water via a seafloor surface expression, resulting in the possible exposure of a variety of resources to WST chemicals (Table 4-7). Such an accident is considered unlikely. The BSEE requires all APDs and APMs to include information on known fractures, faults, and wells in the vicinity of the proposed activity and would not approve any WST in which there is a potential for intersecting a known fault, fracture, or well. In addition, injection pressures would be continuously monitored during a fracturing operation on the southern California OCS. A lack of pressure buildup prior to fracture initiation or a detectable pressure loss during fracture propagation would indicate that a fracture potentially has intercepted an existing pathway (e.g., fault, fracture, or well) to the seafloor[10]; injection of fracturing fluids would cease and formation pressure would be allowed to return to pre-fracturing levels. The return to pre-fracturing formation pressure, together with the pressure from the overlying rock and the overlying hydrostatic pressure, would preclude the movement of WST fluids, hydrocarbons, and formation water from the new fracture to the seafloor surface, greatly reducing the potential of a seafloor surface expression to the ocean. This accident scenario is considered to have a very low probability of occurrence and is not reasonably foreseeable.

4.3.3 Accidents during Handling, Processing, and Disposal of WST Waste Fluids

Following WST fluid injection, WST-related waste fluids (e.g., the flowback fluids) are captured together with hydrocarbons and formation water as part of the production stream. They then pass through the normal processing systems that separate the crude oil, produced water, and natural gas. The WST waste fluids, which are largely seawater, are returned mixed with the produced water and handled as part of the produced water waste stream (Section 4.2.3). Although most of the chemicals present in the injection fluid remain in the formation or are

[10] In general, intersecting a naturally occurring fracture is desired and not of concern. Intersecting previously induced fractures may be of concern if a pathway is created for fluid release through an improperly abandoned wellbore. Wells that have been properly abandoned and cemented will have reduced possibility of creating a pathway for fluid release to the seafloor surface.

TABLE 4-7 Impacting Factors for Potential Accidents during WST Fluid Injection

Accident Event—Impacting Factor	Resource	Potential Effect Evaluated
WST chemical release at a platform following WST equipment malfunction	Air and Water Quality	Localized temporary reductions in air and water quality.
	Benthic Resources, Marine and Coastal Fish and EFH, Sea Turtles, Marine and Coastal Birds, Marine Mammals	Localized effects with exposure to potentially toxic levels of WST-related chemicals; localized, temporary reduction in habitat quality.
	Commercial and Recreational Fisheries	Localized and temporary closure of fisheries due to health concerns. Reduction in abundance of fishing resources (i.e., fish/invertebrates) due to effects of exposure to toxic levels of WST-related chemicals.
Surface expression of WST fluids and hydrocarbons due to well cement failure from repeated fracturing jobs, or from induced fractures intercepting an existing fault or other pathway to the seafloor	Air and Water Quality	Localized (at the platform) reductions in air and water.
	Benthic Resources, Marine and Coastal Fish and EFH, Sea Turtles, Marine and Coastal Birds, Marine Mammals	Localized lethal or sublethal effects of exposure to potentially toxic levels of WST-related chemicals; localized and temporary reduction in habitat quality. Potentially longer-term effects due to hydrocarbon fraction of release.
	Commercial and Recreational Fisheries	Localized and temporary closure of fisheries due to human consumption concerns. Reduction in abundance of fishing resources (i.e., fish/invertebrates) due to effects following exposure to toxic levels of the released fluids. Potentially longer-term effects due to hydrocarbon fraction of release.
	Areas of Special Concern	If the release reaches an area of concern, localized and temporary effects on water quality and biota as above. Localized and temporary reduction in use.
	Environmental Justice	Reduce use of affected areas by low-income and minority populations.

TABLE 4-7 (Cont.)

Accident Event—Impacting Factor	Resource	Potential Effect Evaluated
	Archaeological Resources	Localized minor effects on cultural resources in affected region associated with oiling.
	Recreation and Tourism	Localized and temporary reductions in recreation and tourism.
	Socioeconomics	Local and temporary declines in commercial and recreational fisheries activities, recreation, and tourism from a crude oil release. Temporary cessation oil and gas production.

consumed within the reservoir (e.g., acid solutions become neutralized), some may remain in the waste fluid and become incorporated into the produced water waste stream. An accidental release of some of these chemicals may occur if a leak occurs in a pipeline that is carrying produced water containing WST-related chemicals and this produced water is released to the ocean (Table 4-8). Should such a release occur, there is a potential for some resources to be exposed and affected (Table 4-9).

No aspects of WST use involve activities that could compromise pipeline integrity. Existing vessel traffic and anchorage restrictions along seafloor pipelines currently limit the potential for pipeline breaches due to surface vessels. In addition, pipelines undergo regular external and internal inspection per the BSEE Pacific OCS Region Pipeline Inspection and Monitoring Program (per 30 CFR 250, subpart J), which further limit the likelihood of a release from a produced water pipeline. Given the expected low frequency of WST use on the southern California OCS in the foreseeable future, and the high volume of produced water routinely transported by the pipelines, it is highly unlikely that produced water containing WST-related chemicals would be present at the specific time and location where a pipeline leak actually occurs. Thus, although a pipeline release of produced water containing some WST-related chemicals is possible, such an accidental release has a very low probability of occurrence and is not reasonably foreseeable.

4.3.4 Effects of Response Actions

In the event of an accidental seafloor surface expression during a fracturing WST, the seafloor expression may include hydrocarbons, especially crude oil. In such an event, some resources may be secondarily affected by response actions implemented by the U.S. Coast Guard (which has jurisdictional authority for oil spill response actions) to address any hydrocarbon release (Table 4-10).

TABLE 4-8 Potential Accident Events during Handling, Processing, and Disposal of WST Waste Fluids

WST Activity	Nature of Accident Event	Applicability	Anticipated Likelihood of Occurrence
Handling, processing, and disposal of WST waste fluids.	Release of WST waste fluids following loss of pipeline integrity	Applicable to all WSTs	Anticipated likelihood: very low probability and not reasonably foreseeable. Release would require a pipeline breach at precisely the time when WST-related chemicals would be present in the produced water within the pipeline. No aspect of any WST use creates conditions for increased pipeline breach potential. Existing vessel traffic and anchorage restrictions along seafloor pipelines currently limit the likelihood of pipeline breaches from surface vessels. In addition, pipelines undergo regular external and internal inspection per the BSEE Pacific OSC Region Pipeline Inspection and Monitoring Program (per 30 CFR 250 subpart J).

TABLE 4-9 Potential Impacting Factors for Accidents during Handling, Processing, and Disposal of WST Waste Fluids

Accident Event—Impacting Factor	Resource	Potential Effect Evaluated
WST waste fluid release during collection, platform storage, and pipeline transfer between platforms and onshore facilities	Water Quality	Localized, temporary reduction in water quality.
	Benthic Resources, Marine and Coastal Fish and EFH, Sea Turtles, Marine and Coastal Birds, Marine Mammals	Localized exposure to potentially toxic levels of WST-related chemicals; localized, temporary reduction in habitat quality.
	Commercial and Recreational Fisheries	Localized and temporary closure of fisheries due to human consumption concerns. Localized reduction in abundance of fishing resources (i.e., fish/invertebrates) due to effects of exposure to potentially toxic levels of WST-related chemicals.
	Areas of Special Concern	If the release reaches an area of concern, localized and temporary effects to water quality and biota as above.
	Socioeconomics	Temporary cessation oil and gas production at platforms serviced by the leaking pipeline.

TABLE 4-10 Potential Secondary Effects during Response and Cleanup Activities (for accidental releases including oil)

Response/Cleanup Activity Impacting Factor	Resource Affected	Potential Effect Evaluated
Air emissions during cleanup operations	Air Quality	Temporary localized reduction in air quality due to emissions from cleanup vessels and equipment.
Increased noise associated with cleanup operations	Marine and Coastal Birds, Marine Mammals	Temporary, localized, disturbance and displacement of individuals.
Increased vessel traffic associated with cleanup operations	Sea Turtles, Marine Mammals	Temporary, localized increase in disturbance; increased potential for injury from ship strikes.
Access restrictions due to cleanup activities	Commercial and Recreational Fisheries, Areas of Special Concern, Recreation and Tourism, Environmental Justice	Localized and temporary cessation of use of fishery, recreation, and tourism areas during cleanup operations; localized and temporary cessation of areas used by low-income and minority populations.
	Socioeconomics	Local and temporary declines in commercial and recreational fisheries activities, recreation and tourism, and oil and gas production.

4.4 ASSESSMENT APPROACH

The environmental consequences discussed in subsequent sections of Chapter 4 address the potential impacts that could be incurred as a result of WST operations and accident events under each of the three alternatives that include WSTs. For each of these alternatives, the evaluation characterized the anticipated magnitude and duration of potential environmental effects associated with the impact-producing factors identified in Tables 4-3, 4-5, 4-7, and 4-9. The evaluations characterized potential effects with regard to how widespread any impacts might be (e.g., localized around platforms or affecting a much larger portion of the southern California OCS), the magnitude of any potential effect (e.g., small or large increase in air pollutants, individual biota or populations affected), and the duration of any potential effects (e.g., short term [days or weeks]or long term [months or longer]).

In contrast to Alternative 4 (No Action), Alternatives 1, 2, and 3 all include the use of the same four types of WST, and thus the nature and magnitude of any potential WST-related impacts will be relatively similar among these three alternatives, with the exception of WST-related fluid disposal under Alternative 3. The primary difference between Alternatives 1 and 2 is that Alternative 2 includes operational restrictions (minimum sub-seafloor depth requirement) that may reduce (in comparison to Alternatives 1 and 3) the likelihood of an accidental seafloor surface expression occurring. Except for the possible reduction in such a very unlikely and not reasonably foreseeable accidental release of WST chemicals (see Section 4.3), there are no differences in potential impacts of WST use between Alternatives 1 and 2.

In contrast, Alternative 3 differs from Alternatives 1 and 2 in that it prohibits open ocean discharge of produced water containing WST-related waste fluids, which is currently allowed at all platforms on the southern California OCS under the NPDES General Permit CAG280000. Thus, any potential effects associated with the open water discharge of WST-related waste fluids (which could continue for Alternatives 1 and 2) would not be expected for Alternative 3. However, should the need for new injection wells be identified at some platforms for the disposal of produced water containing WST-related chemicals and fluids, Alternative 3 could include impacts (e.g., seafloor disturbance, noise impacts on marine fish and wildlife, reduction in water quality, increased air emissions) that would be associated with construction of new injection wells. Such potential impacts would not be expected under the other alternatives.

Alternative 4 differs the most from the other three alternatives, as it would completely prohibit the use of WSTs at any of the platforms on the southern California OCS. Thus, any impacts identified from WST use identified for Alternatives 1–3, as well as any potential impacts associated with WST-related accidents, would not be expected under Alternative 4.

4.5 ENVIRONMENTAL CONSEQUENCES

4.5.1 Alternative 1 Proposed Action—Allow Use of WSTs

Under Alternative 1, BSEE will continue to review and approve on a case-by-case basis the use of fracturing and non-fracturing WSTs at the existing production platforms located on the 43 active leases on the southern California OCS (Figure 4-1). Under this alternative, four WST types could be approved for use:

- Diagnostic fracture injection test;
- Hydraulic fracturing;
- Acid fracturing; and
- Matrix acidizing.

4.5.1.1 Geology/Seismicity

Induced seismicity is the primary impacting factor evaluated for the effects on geology of WSTs (Section 4.2.4), including hydraulic fracturing treatments and matrix acidizing stimulations. Between 1982 and 2014, hydraulic fracturing was used 21 times in offshore wells, with seven completions in the Monterey Formation, eight completions in the Upper Repetto sandstone formation, and six in the Lower Repetto sandstone formation (Table 4-1). The largest volume of fracturing fluid used in operations in the Monterey Formation was approximately 177,000 gal (4,200 bbl) (Gail Platform, Well E-8 in January 2010); the volumes of fracturing fluid injected into the Repetto sandstones were in the range of 10,000 to 60,000 gal (238 to 1,400 bbl) (Gilda Platform). These volumes are relatively low when compared to onshore fracturing fluid volumes completed in shale formations in California, which are reported to range from 1.75 to 10 million gal (42,000 to 238,000 bbl) per well per year between 2000 and 2010 (CCST 2015c). Matrix acidizing well stimulation treatments have been documented at the Point Arguello Field (Santa Maria Basin). Typical fluid volumes reported for these treatments were on the order of 15,000 gal (360 bbl) (Houseworth and Stringfellow 2015). By contrast, total produced water associated with offshore oil and gas activities in Federal waters off southern California in 2013 were on the order of 9 million gal (214,000 bbl) per well (based on BSEE 2014); depending on the platform, 50% or more of this volume may be disposed of by injection (Houseworth and Stringfellow 2015).

Because the volume of WST-generated fluids is small relative to the volumes of produced water injected during normal oil and gas production operations (and small relative to onshore volumes of injected fluids overall), the induced seismicity hazard related to the injection of WST fluids is expected to be low under Alternative 1. None of the accident scenarios identified in Section 4.2 would tend to be associated with induced seismicity.

Conclusions. Based on the expected very low frequency of WST use anticipated for the reasonably foreseeable future, together with the comparatively low volumes of WST fluids that could be used for any single WST application, the conduct of any of the three fracturing WSTs (DFIT, hydraulic fracturing, and acid fracturing) or of the non-fracturing WST (matrix acidizing) is not expected to result in any increase in seismicity of the southern California OCS and adjacent coastal counties.

4.5.1.2 Air Quality

WST Operations. Potential impacts of WST use on ambient air quality and climate change under the Alternative 1 Proposed Action would be associated with air emissions from all direct and support activities related to implementing WSTs. Emission sources include engine exhaust from diesel injection pumps, venting or flaring of gases or vapors produced during WST use, engine exhausts from PSVs, and emissions from on-land facility operations and material transport.

Reactive organic gases (ROGs) along with NO_X, are precursors of ozone and secondary PM, which contribute to smog. ROGs, if present in WST fluids, would be controlled per APCD regulations, which require that WST flowback fluids not be sent to open-top tanks or systems vented to atmosphere. Thus, ROG emissions could be controlled through vapor controls on temporary tanks in which WST flowback fluids are stored; flaring of WST vapors would not be employed. Although no measured data on evaporative emissions of chemicals from liquids used during WSTs are available (CCST 2014), such emissions would likely be very small, even in the absence of vapor controls. By comparison, current ROG emissions from oil and gas production accounted for about 1% of the total ROG emissions for the four coastal counties adjacent to the southern California OCS (ARB 2015). Because evaporative emissions from WST liquids would represent a tiny portion of all regional ROG emissions of oil and gas production, they would not adversely impact ozone air quality (CCST 2014).

Emissions from diesel pumps used to perform WSTs, therefore, are the only emissions with the potential to impact air quality and the only emissions treated quantitatively in this analysis. Incremental air emissions from diesel pumps used in WST activities are compared with total regional emissions to assess the potential impacts of WSTs on ambient air quality and climate change.

Currently, some CA counties are in nonattainment for ozone and $PM_{2.5}$ NAAQS and for ozone, PM_{10}, and $PM_{2.5}$ CAAQS (see Table 3-2). As for any oil and gas operations on the OCS platforms, WST operations would emit criteria and toxic air pollutants and greenhouse gases (GHGs). Emissions from diesel engines include NO_x and a small amount of primary PM, ROGs, and CO. Fugitive emissions of ROGs in flowback fluid would be negligible, as noted above. Particulates from engine exhaust are typically less than 1 μm and thus are included with $PM_{2.5}$, which is regulated out of concern for deep lung penetration of small particles. With respect to GHGs, diesel engines contribute CO_2 exhaust emissions, and small fugitive emissions of methane (CH_4), which is a potent GHG.

Based on estimated fuel use[11] of 926 gal (22 bbl) of diesel for pumping during a 250,000-gal (6,000-bbl) WST and using an ARB emission factor for diesel equipment, estimated total emissions for a fracturing WSTs on the southern California OCS would be about 185 lb (0.09 ton) for NO_x and 9.7 lb (0.005 ton) of PM. These emissions are up to about 0.014% of total emissions from offshore oil and gas production activities (Houseworth and Stringfellow 2015), and 0.00004% of total emissions from the four coastal southern California counties (see Table 3-3). Thus, estimated WST-related emissions are negligible compared with those for offshore oil and gas production activities and compared to all emissions in coastal counties.

Based on an emission factor of 22 lb of CO_2/gal of diesel for pumping (CCST 2014), CO_2 emissions from diesel equipment during a 250,000-gal WSTs would be about 9.3 MT, which is negligible compared to CO_2-equivalent GHG emissions from both offshore crude production activities (140,118 MT/yr; Detwiler 2013) and all activities in California (459 MMT/yr; see Section 3.3.2.4). Methane emissions from WSTs are uncertain, but likely far

[11] This fuel use would only occur on platforms that were not electrified via a cable from the shore. No air emissions would be generated from activities on platforms that were electrified via a cable. Published estimates for the Eagle Ford and Marcellus shales (typically about 21,000 gal of diesel fuel over a 2-day period to pump about 135,000 bbl of fracturing fluid [Rodriguez and Ouyang 2013]) located outside of California are employed as the best available data, to which fuel use for WSTs on the southern California OCS waters is assumed to be linearly proportional (CCST 2014). Using the ARB emission factor for diesel equipment, emissions for NO_x and $PM_{2.5}$ were estimated to be about 4,200 and 220 lb, respectively, which falls within the Litovitz et al. (2013) range of estimates derived using similar methodology.

smaller than the direct CO_2 emissions from oil and gas extraction (CCST 2014). Per the ARB inventory, CH_4 emissions accounted for less than 10% of total GHG emissions, on a CO_2 equivalent basis, from all oil and gas production. Sources of ROGs and fugitive CH_4 emissions associated with WSTs would be controlled according to the APCD requirement for vapor controls on flowback fluids.

Air emissions would be controlled through best available control technology and good engineering practices. Historically, WSTs have occurred less than once per year on the southern California OCS (Table 4-1), and have employed typical fracturing fluid volumes in the range of 10,000 to 60,000 gal (238 to 1,429 bbl), with a peak of 177,072 gal (4,215 bbl) at Platform Gail in January 2010; this is smaller than the fluid volume used for emission estimates. Therefore, potential impacts of WST activities on ambient air quality and climate change would be anticipated to be minor, even if several fracturing jobs would occur annually.

With respect to any WST-related toxic air emissions from the facilities in Federal waters, because platforms are more than 3.7 mi offshore of the corresponding coastlines, such emissions would have minor to negligible public health effects; studies indicate that public health risks from exposures to toxic air contaminants (such as benzene and aliphatic hydrocarbons) are greatest within 0.5 mi from active oil and gas development (Houseworth and Stringfellow 2015). Any such emissions would follow the prevailing wind direction in the project area, which is from the west or northwest (Section 3.3.1). WST activities would occur any time of the day, both during the daytime hours when meteorological conditions are favorable for air dispersion and during the nighttime hours when land breeze blows offshore to the ocean under weak synoptic flow.

Accordingly, potential impacts of the offshore WST activities on ambient air quality, mostly ozone and PM pollution, and from toxic air pollutants in coastal communities, would be negligible. In addition, potential effects of WST-related PM emissions on visibility and other AQRVs in the nearest Federal Class I areas (which are located some distance inland) would be negligible as well.

With respect to specific WST technologies, under Alternative 1 total fracturing fluid volumes are assumed to be about 4,200 gal (100 bbl) for diagnostic fracture injection test (DFIT) and typically 250,000 gal (5,952 bbl) for fracturing WSTs (hydraulic fracturing and acid fracturing) and non-fracturing WSTs (matrix acidizing). Emissions estimated here at the 250,000-gal level would scale linearly to larger or smaller injection volumes. Overall, given the small estimated emissions for criteria pollutants and GHGs, none of the WSTs anticipated under Alternative 1 are expected to result in any noticeable impacts on ambient air quality or climate change. This includes reasonably anticipated larger injection volumes, which would at most double the emissions evaluated here.

WST-Related Accident Scenarios. Accidents may occur during the transport of WST chemicals and fluids to platforms, during WST fluid injection, and during the handling, transport, treatment, and disposal of WST-related waste fluids (Section 4.3). Accident consequences of primary concern to air quality are related to releases of ROGs, which could contribute to smog. Accidents on platforms or service vessels that result in surface water spills of WST chemicals or flowback fluids would cause negligible air quality degradation as a result of evaporation of ROGs, because these are absent in, or at most very minor components of, WST fluids. Therefore, surface water releases would cause a negligible decrease in air quality from evaporation of ROGs in WST fluids.

Although not reasonably foreseeable, an accidental seafloor surface expression could release crude hydrocarbons to the sea. A lack of pressure buildup prior to fracture initiation or a detectable pressure loss during fracture propagation would indicate that a fracture potentially has intercepted an existing pathway (e.g., fault, fracture, or well) to the seafloor (Section 4.3.2). In such an event, injection of fracturing fluids would cease and formation pressure would be allowed to return to pre-fracturing levels. The return to pre-fracturing formation pressure, together with the pressure from the overlying rock and the overlying hydrostatic pressure, would preclude the movement of WST fluids, hydrocarbons, and formation water from the new fracture to the seafloor surface, greatly reducing the potential of a seafloor surface expression Potential impacts on ambient air quality and human health as a result of such releases would depend on the location (proximity to coastal populations), size, and duration of releases. Any ROG releases could potentially affect air quality over a few days to weeks, depending on the size and duration of the release. Any resulting degradation in air quality would be localized and temporary.

A DFIT operation employs such small fluid volumes (typically 4,200 gal [100 bbl]), and such short applications of fracturing pressures, that an accident resulting in a seafloor surface expression is not reasonably foreseeable. Non-fracturing WSTs (matrix acidizing) would also be unlikely to pose risks of surface expression accidents, while the potential impacts of a surface accident would be similar for all WST technologies.

Conclusions. Based on the expected very low frequency of WST use anticipated for the reasonably foreseeable future, together with the relatively short duration of any single WST application, the conduct of any of the three fracturing WSTs (DFIT, hydraulic fracturing, and acid fracturing) or of the non-fracturing WST (matrix acidizing) is not expected to result in any noticeable impacts on ambient air quality of the southern California OCS and adjacent coastal counties, or to contribute to climate change. Potential impacts of the offshore WST activities on ambient air quality, mostly ozone and PM pollution, would be negligible under any of the fracturing and non-fracturing WSTs. Potential effects of WST-related PM emissions on visibility and other AQRVs in the nearest Federal Class I areas (which are located some distance inland) would be negligible as well.

4.5.1.3 Water Quality

WST Operations. Water quality could be affected in the vicinity of platforms that discharge WST fluids recovered after use. Recovered WST fluids are typically combined with produced water, processed, and, at various platforms, discharged to the ocean or reinjected into producing formations. Recovered WST constituents, which range from less than 5% to up to

50–70% of the quantity of WST fluids injected in onshore applications in California (CCST 2015b), are combined with and diluted in produced water, which typically originates from multiple other wells that are not conducting WSTs, as described in Section 4.1. Produced water containing WST constituents is discharged under NPDES General Permit CAG280000, which applies concentration limits at the boundary of a 100-m mixing zone. Because permits limits are requirements, no effects on water quality from such discharges are expected beyond the 100-m mixing zone; any effects would be confined to the mixing zone, where WST constituent concentrations would be higher. Because permit limits generally employ a margin of safety, somewhat higher concentrations that could occur within the 100-m mixing zone would not necessarily be harmful, but data is not available to support a determination of absence of effects.

Table 4-11 presents the general types of hydraulic fracturing fluid constituents, their functions, and example chemicals that have been used in onshore applications in California. Water or brine typically makes up over 80% of hydraulic fracturing fluids by mass, with proppant—typically sand—present on the order of 15% of total mass. Other chemicals shown in Table 4-11 make up only on the order of 1% of the hydraulic fracturing fluid mass.

With respect to specific chemicals used, a review of chemical additives used in 1,406 onshore hydraulic fracturing treatments conducted in California between January 30, 2011, and May 19, 2014, found a median of 23 individual components—including base fluids, proppants, and chemical additives—used per treatment (CCST 2015b). A separate recent EPA review of disclosures to “Frac Focus”[12] found a median of 19 chemical additives and a median water volume of 77,000 gal (1,833 bbl) used per treatment in California based on 718 disclosures submitted between January 1, 2011, and February 28, 2013 (EPA 2015).

Table 4-12 presents the 20 most commonly reported hydraulic fracturing components used in onshore treatments in California, excluding base fluids (water and brines) and inert minerals (proppants and carriers), based on records from 1,623 hydraulic fracturing treatments (CCST 2015b). Offshore treatments would presumably use the same or similar chemicals.

Table 4-13 presents hydraulic fracturing fluid composition from onshore treatments as reported to DOGGR[13] (Houseworth and Stringfellow 2015). All treatments were for diatomite but two, which were for Pico/Repetto sandstone, a more likely type of lithology offshore than diatomite. The table shows constituents by mass percent for the fracturing fluid with the highest

[12] The Frac Focus Chemical Disclosure Registry (referred to as “FracFocus”) is a publicly accessible website (www.fracfocus.org) where oil and gas production well operators nationwide can disclose information about the ingredients used in hydraulic fracturing fluids at individual wells. Frac Focus was developed by the Ground Water Protection Council (GWPC) and the Interstate Oil and Gas Compact Commission (IOGCC) in response to public interest in the composition of hydraulic fracturing fluids (EPA 2015).

[13] California Department of Conservation, Department of Oil and Gas and Geothermal Resources (DOGGR). Within 60 days following the cessation of an onshore well stimulation treatment, DOGGR requires that specified information regarding the composition and disposition of well stimulation fluids, including, but not limited to, hydraulic fracturing fluids, acid well stimulation fluids, and flowback fluids, be entered into a Chemical Disclosure Registry that is accessible to the public. The Registry is available at http://www.conservation.ca.gov/dog/Pages/WellStimulationTreatmentDisclosure.aspx.

TABLE 4-11 Chemical Composition of Additives in Fracturing Fluids

Additive Type	Description of Purpose	Examples of Chemicals
Proppant	"Props" open fractures and allows gas/fluids to flow more freely to the wellbore.	Sand (sintered bauxite; zirconium oxide; ceramic beads)
Acid	Removes cement and drilling mud from casing perforations prior to fracturing fluid injection.	Hydrochloric acid (HCl, 3% to 28%) or muriatic acid
Breaker	Reduces the viscosity of the fluid in order to release proppant into fractures and enhance the recovery of the fracturing fluid.	Peroxydisulfates
Bactericide/biocide/ antibacterial agent	Inhibits growth of organisms that could produce gases (particularly hydrogen sulfide) that could contaminate methane gas. Also prevents the growth of bacteria that can reduce the ability of the fluid to carry proppant into fractures.	Gluteraldehyde; 2,2-dibromo-3-nitrilopropionamide
Buffer/pH adjusting agent	Adjusts and controls the pH of the fluid in order to maximize the effectiveness of other additives such as crosslinkers.	Sodium or potassium carbonate; acetic acid
Clay stabilizer/control/KCl	Prevents swelling and migration of formation clays that could block pore spaces, thereby reducing permeability.	Salts (e.g., tetramethyl ammonium chloride potassium chloride (KCl)
Corrosion inhibitor (including oxygen scavengers)	Reduces rust formation on steel tubing, well casings, tools, and tanks (used only in fracturing fluids that contain acid).	Methanol; ammonium bisulfate for oxygen scavengers
Crosslinker	Increases fluid viscosity using phosphate esters combined with metals. The metals are referred to as crosslinking agents. The increased fracturing fluid viscosity allows the fluid to carry more proppant into the fractures.	Potassium hydroxide; borate salts
Friction reducer	Allows fracture fluids to be injected at optimum rates and pressures by minimizing friction.	Sodium acrylate-acrylamide copolymer; polyacrylamide (PAM); petroleum distillates
Gelling agent	Increases fracturing fluid viscosity, allowing the fluid to carry more proppant into the fractures.	Guar gum; petroleum distillates
Iron control	Prevents the precipitation of metal oxides that could plug off the formation.	Citric acid
Scale inhibitor	Prevents the precipitation of carbonates and sulfates (calcium carbonate, calcium sulfate, barium sulfate) that could plug off the formation.	Ammonium chloride; ethylene glycol
Solvent	Additive that is soluble in oil, water, and acid-based treatment fluids; used to control the wettability of contact surfaces or to prevent or break emulsions.	Various aromatic hydrocarbons
Surfactant	Reduces fracturing fluid surface tension thereby aiding fluid recovery.	Methanol; isopropanol; ethoxylated alcohol

Source: CCST (2014).

TABLE 4-12 Most Commonly Reported Hydraulic Fracturing Components Reported in California

Chemical	CASRN	Treatments Using This Chemical
Guar gum	9000-30-0	1,572
Ammonium persulfate	7727-54-0	1,373
Sodium hydroxide	1310-73-2	1,338
Ethylene glycol	107-21-1	1,227
2-Methyl-3(2H)-isothiazolone	2682-20-4	1,187
Magnesium chloride	7786-30-3	1,187
Magnesium nitrate	10377-60-3	1,187
5-Chloro-2-methyl-3(2H)-isothiazolone	26172-55-4	1,184
Isotridecanol, ethoxylated	9043-30-5	1,171
Hydrotreated light petroleum distillate	64742-47-8	1,167
Distillates, petroleum, hydrotreated light paraffinic	64742-55-8	1,129
2-Butoxypropan-1-ol	15821-83-7	1,119
Hemicellulase enzyme	9025-56-3	1,098
1,2-Ethanediaminium, N1,N2-bis[2-[bis(2-hydroxyethyl)methylammonio]ethyl]-N1,N2-bis(2-hydroxyethyl)-N1,N2-dimethyl-, chloride (1:4)	138879-94-4	1,076
1-Butoxypropan-2-ol	5131-66-8	973
Phosphonic acid	13598-36-2	790
Amino alkyl phosphonic acid	Proprietary	668
Boron sodium oxide	1330-43-4	666
Sodium tetraborate decahydrate	1303-96-4	520
Enzyme G	Proprietary	480

Source: CCST (2015b).

reported chemical load and notes those for which toxicity data was available (Houseworth and Stringfellow 2015). The gelling agents, (guar gum and petroleum distillates) represent the largest (non-proppant) chemical component by mass.

Acid fracturing or matrix acidizing treatments typically use on the order of 10–20% strong acids, frequently as 12% hydrochloric and 3% hydrofluoric acid, along with roughly 1% of other chemicals. Some of the additives used in matrix acidizing are the same as those used in hydraulic fracturing (CCST 2015a), presumably serving the same purpose in both treatments.

Acid fracturing, like hydraulic fracturing, uses gelling agents and cross linkers to thicken a water-based “pad” used to initiate fractures. Acids are then pumped in to etch and to create worm holes connecting fractures. The acid is normally gelled, cross linked, or emulsified to minimize fluid leakoff. Fluid loss control is a key function of many of the additives used in acid fracturing.

Matrix acidizing is typically used to repair near-wellbore damage caused by sediment plugging by dissolving mineral particles that interfere with flow into the wellbore. Table 4-14

TABLE 4-13 Hydraulic Fracturing Fluid Composition

Chemical Constituent	CAS	Maximum Percentage by Mass
Crystalline silica: quartz (SiO_2)	14808-60-7	29.08368%
Guar gum	9000-30-0	0.25305%
Paraffinic petroleum distillate	64742-55-8	0.12652%
Petroleum distillates	64742-47-8	0.12652%
Oxyalkylated amine quat	138879-94-4	0.04739%
Methanol[a]	67-56-1	0.03048%
Diatomaceous earth, calcined	91053-39-3	0.02959%
Sodium chloride[a]	7647-14-5	0.02564%
1-Butoxy-2-propanol	5131-66-8	0.02109%
Isotridecanol, ethoxylated	9043-30-5	0.02109%
Cocamidopropylamide oxide	68155-09-9	0.01588%
Cocamidopropyl betaine	61789-40-0	0.01588%
Boric acid (H_3BO_3)[a]	10043-35-3	0.01524%
Methyl borate	121-43-7	0.01524%
Ammonium persulfate[a]	7727-54-0	0.00667%
Nitrilotris (methylene phosphonic acid)	6419-19-8	0.00444%
Quaternary ammonium chloride	61789-71-7	0.00444%
Hemicellulase enzyme concentrate	9025-56-3	0.00379%
Potassium bicarbonate	298-14-6	0.00311%
Glycerol	56-81-5	0.00159%
Caprylamidopropyl betaine	73772-46-0	0.00159%
Acid phosphate ester	9046-01-9	0.00148%
Vinylidene chloride-methylacrylate polymer	25038-72-6	0.00062%
5-Chloro-2-methyl-4-isothiazolin-3-one[a]	26172-55-4	0.00049%
Magnesium nitrate	10377-60-3	0.00049%
2-Butoxy-1-propanol	15821-83-7	0.00042%
2-Methyl-4-isothiazolin-3-one	2682-20-4	0.00024%
Magnesium chloride[a]	7786-30-3	0.00024%
Phosphonic acid	13598-36-2	0.00015%
Ethylene glycol[a]	107-21-1	0.00015%
Crystalline silica: cristobalite	14464-46-1	0.00005%
Hydrated magnesium silicate	14807-96-6	0.00002%
Poly(tetrafluoroethylene)	9002-84-0	0.00001%

[a] Chemical with toxicity data.

Source: Houseworth and Stringfellow (2015).

TABLE 4-14 Matrix Acidizing Fluid Composition[a]

Stages	Chemical Constituent	CAS	Maximum Percentage by Mass
HCl preflush	Acetic acid[b]	64-19-7	0.9828%
	Citric acid[b]	77-92-9	0.8288%
	Hydrochloric acid[b]	7647-01-0	15.3241%
	Methanol[b]	67-56-1	0.0795%
	Diethylene glycol[b]	111-46-6	0.3136%
	Cinnamaldehyde	104-55-2	0.3136%
	Formic acid[b]	64-18-6	0.8317%
	Isopropanol[b]	67-63-0	0.1233%
	Dodecylbenzene sulfonic acid[b,c]	27176-87-0	0.4780%
	2-butoxyethanol[b]	111-76-2	1. 9997%
	Ethoxylated hexanol	68439-45-2	0.1514%
	Ethylene glycol[b]	107-21-1	0.0022%
	Poly(oxy-1,2-ethandiyl), a-(nonylphenyl)-w-hydroxy-b	9016-45-9	0.0088%
Main acid (HCl/HF)	Hydrochloric acid[b]	7647-01-0	14.7779%
	Ammonium bifluoride	1341-49-7	4.3887%
	Methanol[b]	67-56-1	0.0795%
	Diethylene glycol[b]	111-46-6	0.3136%
	Cinnamaldehyde	104-55-2	0.3136%
	Formic acid[b]	64-18-6	0.8317%
	Isopropanol[b]	67-63-0	0. 1215%
	Citric acid[b]	77-92-9	0.0395%
	Hydroxylamine hydrochloride	1304-22-2	0.0395%
	Silica, amorphous - fumed	7631-86-9	0.0003%
	Dodecylbenzene sulfonic acid[b,c]	27176-87-0	0.4707%
	2-butoxyethanol[b]	111-76-2	1.9687%
	Ethoxylated hexanol	68439-45-2	0.1491%
	Ethylene glycol[b]	107-21-1	0.0022%
	Poly(oxy-1,2-ethandiyl), a-(nonylphenyl)-w-hydroxy-b	9016-45-9	0.0087%
Overflush	Isopropanol	67-63-0	0.0854%
	Ammonium chloride[b,c]	12125-02-9	5.0009%
	2-butoxyethanol[b]	111-76-2	0.1685%
	Ethylene glycol[b]	107-21-1	0.0012%
	Poly(oxy-1,2-ethandiyl), a-(nonylphenyl)-w-hydroxy-[b]	9016-45-9	0.0047%

[a] Stimulation fluid for well API 403052539, Elk Hills Oil Field.

[b] Chemical with toxicity data.

[c] These chemicals exceeded the toxicity limits for some species.

Source: Houseworth and Stringfellow (2015).

presents matrix acidizing fluid compositions as reported to DOGGR for onshore applications in California (Houseworth and Stringfellow 2015). The table presents three distinct fluids that are commonly used sequentially for acidizing: (1) an HCl acid preflush fluid; (2) a main acidizing fluid that was generated from mixing hydrochloric acid and ammonium bifluoride to produce an HCl/HF mud acid (some operations use mud acid, while some operations primarily use 15% HCl); and (3) an ammonium chloride overflush fluid. This table also indicates the constituents for which toxicity data is available (Houseworth and Stringfellow 2015).

Many of the chemicals listed in Tables 4-13 and 4-14 would be present at low concentrations in produced water discharges associated with WSTs. Because WST flowback fluids are mixed and diluted with much greater volumes of produced water, concentrations of WST fluids at platform discharge points would be low and would appear infrequently, while in some cases WST flowback fluids are captured separately and sent to shore for treatment and disposal. Effects on water quality would be of most concern near platform outfalls; no effects would be expected after dilution within the 100-m mixing zone.

Potential Marine Effects Mediated by Discharges to Water. Although a discussion of the toxicity of WST chemical constituents in produced water discharges to marine organisms may not be strictly an issue of water quality, such effects are touched on here as part of an overarching evaluation of the effects of such discharges on the marine environment mediated by water. More detailed discussions of marine toxicity are presented in the appropriate resource sections that follow.

Due, in part, to the lack of toxicity data for many constituents of WST fluids, potential effects on marine life within the mixing zone are not fully understood. Some recent studies have been conducted to address potential effects within the mixing zone of produced water discharges, which may or may not have included WST constituents. Little effect on water quality was found in the immediate vicinity of the platforms in a study of discharge plumes (Applied Ocean Science 2004). There were no differences in salinity, temperature, or turbidity between background locations and locations within 25–50 m of platforms. The study also reported no measurable impact to temperature, salinity, density, or turbidity of the receiving waters within the zone of initial dilution (i.e., within 100 m) (Section 3.4.2.1).

In other studies, Gale et al. (2012, 2013) compared exposures to Pacific sanddab (a flatfish), kelp rockfish, and kelp bass to petroleum hydrocarbons from 23 oil platforms and from natural sites offshore Goleta, California, in the SCB. Platforms sites were found to be no more polluted than the nearby natural areas, exhibiting only low concentrations of PAHs, polychlorinated biphenyls (PCBs), DDTs, and other contaminants (Section 3.4.2.1). Likewise, Love et al. (2013) found that the concentrations of 21 elements in fish near platforms were not elevated compared to those in natural areas. These and other studies are summarized in a 2015 case study of the effects of offshore hydraulic fracturing and acid stimulation treatments in the California Monterrey formation (Houseworth and Stringfellow 2015). Potential effects on marine life are discussed further in Sections 4.5.1.4 through 4.5.1.8.

Because (1) WSTs are infrequent activities, (2) WST fluids contain <1% chemical additives, and (3) recovered WST fluids are mixed and highly diluted with much greater volumes of produced water, it is unlikely that the presence of WST chemical constituents at expected levels after mixing with produced water would alter the conditions observed near platforms, as reported in these studies of produced water discharges.

Discharges under NPDES General Permit CAG280000. Discharges from all 23 platforms in the southern California OCS are regulated under NPDES General Permit CAG280000, as discussed in Section 3.4.1. This permit includes WST fluids under discharge category for Discharge 003—Well Treatment, Completion and Workover Fluids (Part II.C), and explicitly covers well completion, well treatment operations, and well workover operations (EPA 2013a). Thus, discharges of recovered WST fluids must be in compliance with the NPDES general permit.

The permit further stipulates that if well treatment, completion, or workover fluids are commingled with produced water, then the effluent limitations and monitoring requirements for well treatment, completion, and workover fluids do not apply; instead, the effluent limitations and monitoring requirements for produced water apply to the comingled fluids. The permit does not specify volume limits for Discharge 003, but does limit the volume of produced water (Discharge 002) discharged from platforms. Table 4-15 presents the effluent limitations and monitoring requirements for Discharge 002 and Discharge 003 under the permit.

In addition, permittees are required to maintain an inventory of the quantities and concentrations of the specific chemicals used to formulate well treatment, completion, and workover fluids. If there is a discharge of these fluids, permittees must report the chemical formulation, concentrations, and discharge volumes of the fluids, as well as the type of operation that generated the discharge in the associated quarterly Discharge Monitoring Report (DMR) submitted to the EPA, Region 9. This inventory would be available to the EPA in the event of well failure or another accident resulting in an unexpected discharge so the EPA may assess emergency response needs. This requirement was added to permit requirements in part to address concerns regarding discharge of hydraulic fracturing fluids (EPA 2013b). The requirement also is similar to requirements for drilling muds and hydrotest water. The permit also provides that the permit may be reopened and modified if new information indicates that the discharges (including hydraulic fracturing chemicals) could cause unreasonable degradation of the marine environment (EPA 2013b). The most recent well stimulations conducted on the Pacific OCS to which the NPDES general permit requirements were in effect were two hydraulic fracturing stimulations completed by DCOR on platform Gilda in late 2014 and early 2015.

To address the potential toxicity of unspecified WST constituents in discharges, the NPDES general permit requires periodic toxicity testing of effluents using a whole effluent toxicity (WET) test. The EPA specifically noted in its response to comments on the draft permit that requiring the WET test for produced water will help address concerns regarding the toxicity of hydraulic fracturing chemicals (EPA 2013c). The WET test, conducted on 24-hr composite samples, uses three test organisms (red abalone, giant kelp, and topsmelt) to assess the toxicity of discharge waters (EPA 2013a).

TABLE 4-15 NPDES Effluent Limitations and Monitoring Requirements (Discharge 002—Produced Water and Discharge 003—Treatment, Completion and Workover Fluids)

Waste Type	Effluent Characteristic	Discharge Limitation	Measurement Frequency	Sample Type/Methods	Reported Values
Discharge 002—Produced Water					
Produced water	Flow rate (BWD)	N/A	Daily	Estimate	Monthly average
	Oil and grease	29 mg/L monthly average; 42 mg/L daily max.	Weekly Weekly	Grab/ Composite Grab/ Composite	The average of daily values for 30 consecutive days; the maximum for any one day.
Discharge 003—Treatment, Completion and Workover (TCW) Fluids					
All TCW fluids	Number of jobs	N/A	Once/job[a]	Count	Type and total number of jobs
	Discharge volume (bbl)	N/A	Once/job	Estimate	Discharge volume per job
	Free oil	No discharge	Once/discharge	Grab/static sheen test	Number of times sheen observed
	Oil and grease	42 mg/L max. daily; 29 mg/L monthly average	Once/job	Grab	Max for any one day and the average of daily values for 30 consecutive days

[a] The type of job where discharge occurs (i.e., treatment, completion, workover, or any combination) shall be reported.

In the preparation of the final permit, EPA Region 9 made changes to the monitoring frequency in the proposed permit based on input from stakeholders. For chemical constituents where reasonable potential was demonstrated for a given platform to discharge chemicals of potential concern, the monitoring frequency was increased from quarterly to monthly. For effluent toxicity, the initial monitoring frequency for the WET test was increased from annually to quarterly. After four consecutive quarters of “pass” results for a given test species, annual testing is required. Quarterly testing would resume after any “fail” result from the annual tests, until four consecutive “pass” results were again obtained (EPA 2013b,c).

The specified WET tests employ protocols from the EPA’s manual, “Short-term Methods for Estimating the Chronic Toxicity of Effluents and Receiving Waters to West Coast Marine and Estuarine Organisms” (EPA 1995). This manual describes tests used to estimate the highest concentration of a chemical that produces no observed adverse effects, or a specified percent reduction in response, in a test organism from a chronic exposure; it also measures such responses as fish larval growth and survival rate. Using multiple test organisms increases the test's response to a wide variety of toxic chemicals with different modes of toxicity; the test organisms would be exposed to all constituents present in effluents at once and would respond to any synergistic toxicity among constituents.

Because discharge waters are sampled on a regular schedule, as specified in the General NPDES Permit, the timing of sampling for a WET test is not specifically coordinated with the conduct of WST activities. For example, depending on when a WST is conducted, WST fluid constituents may not be present in the sampled discharges when quarterly WET tests are performed. This lack of coordination has been identified as a concern for the protectiveness of the General Permit with respect to WST fluids (Houseworth and Stringfellow 2015).

This concern can be considered in light of the larger monitoring program supporting the EPA's implementation of the General Permit and the potential concentrations and toxicity of WST constituents in discharges. The EPA employs a multifaceted approach to protect marine resources from platform discharges, of which WST chemicals are one of several discharges of potential concern, which includes routine discharges of produced water and other platform effluents. In addition to periodic testing using the WET test, the permit requires oil and grease sampling, as well as visual monitoring of free oil in conjunction with each WST (Table 4-11). Such a testing strategy guards against chronic adverse conditions via the WET test, and relies on oil and grease tests and free oil observations as indicators of a loss of overall treatment system control.

With respect to WST fluid constituents in discharges, concentrations for all constituents can be estimated from quantities injected and levels of dilution in produced water, both of which are known quantities. Estimates would be upper limits, because some fraction, often a major fraction, of WST fluids are retained in the formation and not recovered. Potential toxicity can be assessed for individual constituents using toxicity values and estimated concentrations in discharges. For constituents of unknown toxicity, potential toxicity would be evaluated on the basis of reasonably representative toxicity values. This approach to toxicity assessment could reasonably be used in lieu of directly monitoring individual WSTs using the WET test, while periodic WET tests under the permit would serve as a further protective measure and would test all constituents in actual conditions and responds to potential toxic interactions. The following paragraphs further explore the approach described here.

Chemical constituents of fracturing fluids are typically present at a level of less than 1% of the injected fluid (Table 4-13). For a 60,000-gal (1,428-bbl) treatment stage, approximately 600 gal (14 bbl) of chemicals would be injected. In the formation, WST constituents may adsorb to formation surfaces and be recovered slowly, or not at all in flowback fluids, while a small portion will partition into and be recovered in the oil phase; most WST chemical additives are water soluble, and the bulk appears in the water phase of recovered fluids. Hydraulic fracturing treatments typically return only about 5% of the injected fluids, while matrix acidizing may recover 50–70% of fluids (CCST 2015b). Recovered fluids are highly diluted in the combined produced water from the treated well and other wells. The timing of the appearance of WST constituents in produced water discharges would depend on the rate of release and recovery from the formation and the capacity and rate of treatment of the produced water treatment system. At a pumping rate of up to 20 bbl/min of injection fluid, the injection phase of well stimulation is typically completed in 4–8 hrs. Upon returning a well to production, the majority of any recovery of stimulation fluids occurs typically within 1 week. Recovered fluids mixed with produced water are typically treated within 30 hr of recovery from a well and discharged to the ocean after transfer back to a discharging platform within another 12 hr. WST constituents might thus be present in the combined treated produced water discharges for a week to 10 days or so after use, thus presenting a relatively small window of potential overlap when samples are taken for WET testing, which occurs at most quarterly.

Discharges would be diluted by roughly another three orders of magnitude within the NPDES 100-m mixing zone for compliance with the permit. Effluent testing for compliance with the NPDES general permit would apply this additional dilution factor to the results of the effluent samples. Final constituent concentrations at the mixing zone boundary would be quite low (in the sub-ppm range).

Acids used in WSTs are largely spent and neutralized during use, as their purpose is to dissolve mineral materials in the formation. Flowback fluids from acid treatments typically have a pH of 2–3 or greater, approaching neutral pH. Such fluids can be further neutralized to pH > 4.5, if need be, prior to introduction to produced water treatment equipment (API 2014).

Potential Marine Ecotoxicity of Permitted Discharges. The 2015 CCST case study of the potential environmental effects of WST use in the California offshore Monterrey formation reviewed studies of the potential marine ecotoxicity of hydraulic fracturing and acid stimulation treatment constituents (Houseworth and Stringfellow 2015). The authors concluded that, although the effects of produced water have been shown to have some subtle sublethal impacts on reproductive behavior and possibly on the overall health of some species, contamination studies suggest that contaminant exposure levels, upon dilution at discharge points, have remained below levels that result in adverse impacts (Houseworth and Stringfellow 2015).

In a tabletop exercise, CCST performed a coarse toxicity screen of hydraulic fracturing fluid and matrix acidizing fluid for the respective compositions presented in Tables 4-13 and 4-14. The predicted average concentration of each chemical following dilution was compared to the lowest available acute or chronic LC50 or EC50 toxicity value[14] for 90 marine species in the following six species groups: algae, moss, fungi; crustaceans; fish; invertebrates; mollusks; and worms. The hydraulic fracturing case study included 33 chemicals, of which seven (21%) had toxicity data for marine organisms, and 26 (79%) did not. Of the seven chemicals with toxicity data, none was predicted to occur at concentrations above acute or chronic toxicity levels. The matrix acidizing case study included 17 distinct chemicals, of which 12 (71%) had toxicity data in marine organisms, and five (29%) did not. Out of the 12 chemicals with toxicity data, two were predicted to occur at concentrations above acute or chronic toxicity levels: ammonium chloride and dodecylbenzenesulfonic acid (see Table 4-14). The study used a dilution factor of 746:1, the average of the mixing zone dilution factors for the platforms under the NPDES general permit, to estimate concentrations at the mixing zone boundary. The study did not

[14] LC50 is the exposure concentration of a chemical that is lethal to 50% of test organisms. EC50, similarly, is the exposure concentration that results in a specific toxic response in 50% of test organisms.

account for recovery of fluids after use or for any dilution in produced water. Thus, actual concentrations at the mixing zone boundary would be far lower than the values assumed in this exercise.

The biocide 5-chloro-2-methyl-3(2H)-isothiazolone (CMIT) was associated with some of the highest acute or chronic toxicity for marine species out of the chemicals screened for in this case study. However, under the conditions of the case study, CMIT would have predicted concentrations below toxic levels in surrounding waters. Note that biocides are routinely used during oil production not employing WSTs. The lack of toxicity data for 31 of the 48 distinct chemicals was identified as a problem with this evaluation approach, as was the lack of available data on chronic impacts of these chemicals in the marine environment. The authors identified these issues as critical data gaps in the analysis of potential impacts of offshore discharges of WST waste fluids to sensitive marine species (Houseworth and Stringfellow 2015).

A number of factors mitigate concerns related to unknown toxicity of WST fluid constituents. The ability of the WET test to respond to a wide variety of toxic chemicals and to mixtures of chemicals such as WST fluids, including possible toxic interactions, is discussed in some detail above. In addition, the known toxicity of a portion of the WST constituents would be expected to be fairly representative, or even conservatively representative, of the unknown portion, because toxicity studies tend to be performed on chemicals expected to be of concern (e.g., biocides), particularly chemicals used in volume. Finally, levels of WST constituents will be low in discharges—much lower than in the CCST tabletop exercise discussed above—due to the effects of retention in the formation and dilution with produced waters from multiple wells.

Potential Effects of Specific WSTs. Table 4-16 summarizes the potential environmental effects on water quality of ocean discharges of the various WSTs analyzed in this EA. Due to the overall small volume of fracturing fluids used and the short duration of the operation, conducting a DFIT is not expected to have any effects on water quality under normal circumstances.

Typical hydraulic fracturing treatments would employ on the order of 250,000 gal (5,952 bbl) of fracturing fluid, implemented in, for example, four 60,000-gal (1,428-bbl) stages. Such treatments typically recover only on the order of 5% or less of the initial injection fluid volume in the flowback fluid (CCST 2015b); the remainder is retained in the formation. Recovered hydraulic fracturing fluids are contained in produced water, which is treated and discharged under NPDES General Permit CAG280000, or reinjected into the formation, which may be a beneficial use in maintaining formation pressure. As discussed in the foregoing sections, discharges of produced waters containing hydraulic fracturing fluids would be expected to have no effects on water quality due to the very low concentrations of WST constituents that would be present in the discharged water, and the further dilution that would occur in the permit mixing zone following discharge. Monitoring conducted under the permit, including use of the WET test, would provide a further measure of protectiveness.

Acid fracturing treatments contain strong acids (usually hydrochloric and hydrofluoric acid) in addition to other chemical additives such as gels and cross-linkers, which serve to thicken fracturing fluids and prevent fluid loss to large fissures in the formation. It is possible

TABLE 4-16 Potential Effects on Water Quality of WST-Related Platform Discharges

WST	WST Fluids and Discharges	Potential Effects
Diagnostic fracture injection test (DFIT)	Injected WST fluid volume <4,200 gal (100 bbl). Composition: hydraulic fracturing fluid with roughly 1% (42 gal [1 bbl]) chemical constituents. Discharge: very low concentration of hydraulic fracturing fluid constituents.	No effects expected, even close to the discharge point, due to low concentrations of WST constituents in discharge.
Hydraulic fracturing	Injected WST fluid volume typically 250,000 gal (5,952 bbl). WST composition: hydraulic fracturing fluid with roughly 1% chemical constituents. Recovery of WST fluids <5% (CCST 2015b). Discharge: low concentration of injected fluid constituents comingled with produced water, within NPDES limits.	No effects on water quality indicators; potential subtle effects on some marine organisms, but not possible to differentiate from effects of normal constituents of produced water.
Acid fracturing	Injected WST fluid volume: assume 250,000 gal (5,952 bbl). Chemical content: 15% HCl, 5% HF, and 1% other chemicals. Recovery of WST fluids assumed intermediate between hydraulic fracturing and matrix acidizing. Discharge: low concentration of injection fluid constituents and neutralized acids comingled with produced water, within NPDES limits.	No effects on water quality indicators; potential subtle effects on some marine organisms, but not possible to differentiate from effects of normal constituents of produced water.
Matrix acidizing	Injected WST fluid volume: assume less than 250,000 gal (5,952 bbl). Chemical content: 15% HCl, 5% HF, and 1% other chemicals. Recovery of WST fluids: 50–70%. Discharge: low concentration of injection fluid constituents and neutralized acids comingled with produced water, within NPDES limits.	No effects on water quality indicators; potential subtle effects on some marine organisms, but not possible to differentiate from effects of normal constituents of produced water.

that some of the same constituents used in hydraulic fracturing or matrix acidizing presented in Tables 4-13 and 4-14, respectively, with potential toxicity to marine life are also use in acid fracturing and would present the same risks to marine life near discharge points, as described above. Overall, however, fracturing fluid chemical constituents in discharged produced water would be at very low levels and would have no more than subtle effects on marine life near discharge points. Toxicity monitoring using WET testing would protect against the discharge of WST constituents at toxic levels. Acids used in treatments would be largely neutralized by formation minerals during use and thus would produce no effects on water quality or marine life from discharges of flowback fluids combined with produced water.

Matrix acidizing fluids might contain constituents that could be toxic to marine life (Houseworth and Stringfellow 2015). As for acid fracturing, toxicity monitoring using WET testing would protect against the discharge of WST constituents at toxic levels, while acids used in treatments would be largely neutralized in flowback fluids and in discharged produced water and would have no effects on water quality or marine life.

WST-Related Accident Scenarios. Two types of accident scenarios were identified in Section 4.3 as representing plausible pathways for the release of WST fluids and hydrocarbons, surface accidents resulting in a potential release from platforms to the ocean surface (which are reasonably foreseeable but not likely to occur), and accidents resulting in a release from the seafloor, referred to as a “surface expression” (which are not reasonably foreseeable and of very low likelihood of occurrence). The potential effects on water quality of these two types of accidents are described in the following sections.

Sea Surface Accidents. Accidents at the sea surface would result in releases of a somewhat different nature than seafloor releases. As described in Section 4.3, such accidents would occur during shipping, loading, and unloading of WST materials onto and off of vessels and transfers to platforms; accidents involving WST injection fluids on platforms; and accidents involving WST flowback fluids on platforms and in pipeline transport to and from treatment facilities. Releases of WST fluids to the ocean would occur as a result of breaches of containers, tanks, or pipelines.

The volume of WST-related fluids that could be released by such accidents is limited to the size of the shipment containers used, and by the storage capacity for such fluids on platforms or on PSVs (Section 4.3). Accidental releases of recovered WST fluids post-use from pipeline leaks would be similarly limited. At a platform, recovered WST fluids would be highly diluted in produced water from the well undergoing the WST, and potentially further diluted by produced water from other wells and platforms (Section 4.2.3). Any release of WST flowback fluids from a leak in these pipelines would represent a small incremental release of WST fluid constituents contained within releases of produced water or crude oil.

Effects on water quality caused by a release of WST injection fluids or WST flowback fluids would be a temporary localized degradation of water quality near the point of the release. Effects would diminish with distance due to dilution in seawater, and would be incremental to greater effects from the release of associated produced water or crude oil. In the case of a breach of a produced water pipeline, effects on water quality would be similar to the routine discharge of produced water: minor and limited to near the discharge point. Effects of a breach of a crude oil pipeline containing WST flowback fluids would be dominated by those of released crude oil.

A direct spill of WST fluids would have potentially greater effects than a release of diluted WST constituents in flowback fluids. The effects of a direct spill are approximated by the tabletop coarse toxicity screen discussed above; concentrations of constituents with known toxicity, with a few exceptions, would be below toxic effect levels at the mixing zone boundary. Thus, due to rapid dilution at the point of release, toxic concentrations would exist over a very short range and for a short time where marine life could be exposed and affected, and mobile species would spend very little time within the toxic zone. Thus, effects on marine life from the direct release of WST fluids would be expected to be minor.

Sub-seafloor Accidents. In the event of surface expression during a hydraulic fracturing WST, effects on water quality would depend on the size and duration of the release. Liquid and gaseous hydrocarbons released at the seafloor would rise as a plume to the sea surface, where they would form an oil slick that would be spread by currents and winds. Gaseous and volatile components of the slick would evaporate, affecting air quality, but reducing the mass of hydrocarbons in seawater. Over time, remaining hydrocarbons would oxidize and weather, forming particles that, if more dense than water, would eventually sink to the seafloor where oil would be subject to incorporation in sediments and to degradation by benthic organisms. Large oil slicks on the sea surface would likely foul coastlines, given the close proximity of the producing platforms to the coast. Potential effects on marine and coastal biota and habitats are discussed in Sections 4.5.1.4 through 4.5.1.8.

Small releases on the order of tens of barrels of crude would have short-term and localized effects on water quality. Such effects would be similar to those from natural oil seeps in the area, to which seafloor surface expression would temporarily add an additional influx of crude. Such effects include a surface oil sheen, formation of tar balls, and seafloor deposition of weather oil, as discussed in Section 3.4.2.1.2.

Larger volume releases, on the order of hundreds of barrels or more, although increasingly unlikely, would be more likely to foul beaches and coastal areas. Effects on water quality would be similar to those from historical oil spills in the project area of this magnitude, as discussed in Section 3.4.2.1. The effects of greatest concern would be on marine life, other wildlife, recreation, and commercial fishing. Effects on human health and safety, except on workers involved in cleanup, would generally not be a concern. Cleanup workers would be exposed to physical hazards, primarily. Chemical exposures would be limited via the use of personal protective equipment and by limiting exposure time. As with previous oil spills, direct effects would be mainly confined to within a few miles of the release point. However, ongoing low-level releases from oiled sediments would continue to contribute low levels of hydrocarbons to seawaters for months, to possibly years, into the future. Existing natural physical and biological degradation processes would ultimately degrade or remove hydrocarbons from seawater. Oil slicks would follow prevailing currents in the Santa Barbara channel (Figure 3-12).

Potential Effects of Specific WSTs under Accident Scenarios. The potential effects of accidental releases of WST fluids used in various WST treatments are summarized in Table 4-17. Given the small volume of fracturing fluids employed and short duration of the tests, DFIT treatments would have very low likelihood of causing a surface expression of oil from the seafloor. Above-surface handling accidents would be unlikely due to the small volumes of fluids involved, and the impacts of any spills would be minimal.

Hydraulic fracturing treatments would include the potential for both seafloor and surface accidents. While very unlikely, effects of a surface expression could include a temporary degradation of water quality through the release of crude oil and gas from the seafloor. Effects could be mitigated by cessation of the operation upon detection of a loss of pressure, thus removing the driving force for the oil release. In addition, the formations that would be fractured in the project area are mostly already depleted of formation pressure from past production, while the pressure of overlying rock and seawater would limit surface expression of crude oil. Thus, only a limited quantity of crude oil would be expected to be released under such an accident.

Surface accidents resulting in releases of WST fluids to the ocean would be possible during hydraulic fracturing treatments. The volume of fluids potentially released would be limited by the size of containers used to transport and store fluids. A direct release of fracturing fluids to the ocean would cause a short-term, localized degradation of water quality and could be toxic to marine life in the immediate area of the release. The effects of accidents resulting in the release of flowback waters would be minor and similar to the effects of permitted discharges of produce water containing hydraulic fracturing fluid constituents.

Accidents involving acid fracturing treatments would have effects similar to those of hydraulic fracturing seafloor and surface accidents. The use of acids would not increase the effects of releases on water quality nor to marine life. Acids released directly in surface accidents would be quickly diluted and neutralized by seawater. The effects of accidental releases of flowback fluids would be similar to those of hydraulic fracturing accidental flowback fluid releases.

Matrix acidizing treatments would not incur the risks of seafloor releases, given the reduced pressures used with matrix acidizing. The effects of surface accidents would be similar to those of other WSTs, because similar volumes and handling and storage of treatment fluids would be involved. In a direct spill, acids would be quickly diluted and neutralized by seawater, while some other matrix acidizing chemicals might be at levels toxic to marine life in the immediate vicinity of a spill, as discussed above. Any effects on water quality would be localized and short lived.

Conclusions. Under Alternative 1, the proposed action, **t**he use of fracturing (DFIT, hydraulic fracturing, and acid fracturing) or the non-fracturing WST (matrix acidizing) is not expected to adversely affect water quality. Recovered WST fluids would be mixed with produced water, treated, and discharged under NPDES General Permit CAG280000. Effluents would be routinely monitored for specific constituents, for free oil, and for oil and grease assay, and would be subjected to WET testing for general toxicity. Due to the permit limits and

TABLE 4-17 Potential Effects on Water Quality of WST-Related Accidents

WST	Accidental Releases of WST fluids or Crude Oil	Potential Effects on Water Quality
Diagnostic fracture injection test (DFIT)	Surface expression of crude from a potential seafloor accident.	No effects expected due to short duration of tests and low likelihood of surface expression.
	WST fluid release during vessel delivery, offloading, platform storage, pipeline delivery, or injection.	No effects expected due to very low volume of WST fluids used and secure containers.
	Release of WST flowback fluid during collection, storage, or pipeline transfer to and from shore.	Minor effects, at most, are possible, and would be incremental to (and likely not discernible from) the effects of release of associated produced water.
Hydraulic fracturing	Surface expression of crude from a potential seafloor accident.	Minimal effects expected due to monitoring and mitigation measures in place, combined with an absence of reservoir pressure that would support a surface expression.
	WST fluid release during vessel delivery, offloading, platform storage, pipeline delivery, or injection.	Minor effects at most due to relatively small potential releases from small unit volumes used offshore and rapid dilution of any released fluids.
	Release of WST flowback fluid during collection, storage, or pipeline transfer to and from shore.	Minimal effects due to dilute concentrations, and further rapid dilution following any release.
Acid fracturing	Surface expression of crude from a potential sub-seafloor accident.	Same as for hydraulic fracturing.
	WST fluid release during vessel delivery, offloading, platform storage, pipeline delivery, or injection.	Same as for hydraulic fracturing, but with additional hazards from acids, mainly to workers.
	Release of WST flowback fluid during collection, storage, or pipeline transfer to and from shore.	Similar to hydraulic fracturing, assuming that the same non-acid chemical additives are used. Injected acids would be mostly neutralized in the formation; minor effects.
Matrix acidizing	Surface expression of crude from a potential sub-seafloor accident.	No risks of a surface expression expected.
	WST fluid release during vessel delivery, offloading, platform storage, pipeline delivery, or injection.	Similar to hydraulic fracturing and acid fracturing, but effects on marine life could be greater from some matrix acidizing constituents with higher toxicity than the fracturing additives.
	Release of WST flowback fluid during collection, storage, or pipeline transfer to and from shore.	Reduced compared to accidents prior to injection due to dilution and neutralization of acids; minor effects.

monitoring, it is expected that marine life protected under such measures would be effectively protected from any adverse effects of WST constituents in permitted discharges. The accidental release of WST-related chemicals is largely considered unlikely and not reasonably foreseeable, with the possible exception of a platform accident. In the event that an accidental release occurs, the release would likely be small and any effects would be limited and short term. Above-surface accidents resulting in the direct release of WST fluids or of flowback fluids containing WST constituents would have at most minor, localized, and temporary effects on water quality and marine life, and any such effects would be limited by the small quantities of transported or stored WST fluids needed and present at any one time or location, the ability to limit releases once started, and rapid dilution of released fluids in seawater.

4.5.1.4 Ecological Resources

Benthic Resources.

WST Operations. Under Alternative 1, potential WST impacting factors applicable to benthic organisms and their habitats are associated with the permitted platform discharge of produced water containing WST fluids (Section 4.2.4). Although hydraulic fracturing WST fluids make up only a small fraction of the total produced water, several compounds that are toxic to benthic organisms may be present in the discharge, such as biocides, acids, salts, hydrocarbon solvents, and surfactants (Houseworth and Stringfellow 2015). Similarly, matrix acidizing WSTs may release acids and ammonium compounds, which can be toxic to benthic organisms at high enough doses. Potential impacts from the discharge of produced water containing WST fluid chemicals could include localized exposure of benthic organisms to toxic levels of WST chemicals through direct contact with contaminated water or from ingestion of contaminated food.

At platforms on the southern California OCS, produced water containing WST fluid constituents can be disposed of through reinjection to a reservoir or through permitted discharge to the ocean. Properly reinjected produced water would not impact benthic organisms or habitat. In contrast, surface discharge of produced water (including WST chemicals) into the ocean could affect benthic resources, although exposure of benthic resources to toxic levels of WST chemicals would not be expected. Because of the infrequent use of WSTs at platforms on the southern California OCS, the discharge of produced waters containing WST chemicals would also occur infrequently (although acid treatments are more common) and on relatively few platforms.

In addition, the waste water that is discharged from platforms is regulated by NPDES General Permit CAG280000 (see Section 4.5.1.2), which requires that contaminants in the discharged water not exceed concentrations specified in the permit within 100 m of the discharge point. Although non-exceedance concentrations for WST-related chemicals are generally not specified, NPDES General Permit CAG280000 requirements include toxicity testing with two common benthic species, red abalone (*Haliotis rufescens*) and giant kelp (*Macrocystis pyrifera*).

To date, wastewater discharged from platforms on the southern California OCS has passed all toxicity tests (Houseworth and Stringfellow 2015). However, few of the potential WST fluid constituents have toxicological bioassay data available (Tables 4-13 and 4-14).

The composition and toxicity of many WST fluid constituents have not been studied with regard to marine invertebrates, and chronic or acute toxicity concentrations have not been established (Houseworth and Stringfellow 2015). For example, Houseworth and Stringfellow (2015) modeled the discharge concentrations of several WST constituents and generally found the concentrations were below levels associated with chronic and acute toxicity to marine organisms (including invertebrates). However, a toxicity screening of WST constituents found at least two commonly used constituents of matrix acidizing fluids to be potentially acutely toxic to marine organisms (Stringfellow et al. 2015). However, acids used in acid matrix WST would be largely neutralized by formation minerals and thus would produce minimal effects on benthic organisms. Despite the potential toxicity of WST constituents, the potential for release and the potential volume released would be very small. Consequently, exposure of biological communities to toxic levels of WST constituents is unlikely. The potential marine toxicity of WST fluids is discussed in more detail in Section 4.5.1.2.

Some biological surveys around oil and gas platforms—as well as laboratory toxicity tests using produced water from offshore platforms in California—suggest localized, temporary, species-specific impacts on or benefits to marine invertebrates from produced water discharges (Osenberg et al. 1992). However, these were studies of produced water and are not necessarily applicable to WST fluids alone, which would constitute a very small fraction of any discharged produced water. In addition, platforms on the southern California OCS are in water where the depth ranges from about 130 to 1,197 ft (40 to 365 m), so considerable dilution would be expected to occur before the produced waters with WST chemicals would reach benthic habitats and their biota. Consequently, WST-related waste fluids discharged under these permits are unlikely to adversely affect benthic organisms and habitat.

WST-Related Accident Scenarios. The accidental release of WST fluids could occur during vessel delivery, offloading, and injection, while the accidental release of produced water containing WST-related fluids could occur during their collection or pipeline transfer between platforms and to shore (Section 4.3). While many of these types of accidental releases are unlikely and not reasonably foreseeable, potential impacting factors associated with such accidents that could affect benthic resources are primarily associated with the accidental release of WST fluids, WST-related waste fluids, and crude oil (Tables 4-5, 4-7, and 4-9). If an accidental release from surface operations were to occur, the quantity of WST fluid released would be small due to the quantity of WST fluids involved; any such release would result in a localized, temporary reduction in water quality (Section 4.5.1.2) , which would dissipate quickly with dilution the open ocean.

In an accident resulting in a surface expression, which is very unlikely and not foreseeable (Section 4.3.2), the potential quantities of hydrocarbons or WST fluids exiting the seafloor to the overlying water column would not be expected to have appreciable impacts on benthic resources for several reasons. First, the surface expression of biologically significant concentrations of WST fluids is unlikely because real-time pressure monitoring during WST implementation would identify potential contact with an existing well or active fault with a connection to the seafloor, and result in immediate cessation of WST. In addition, existing low reservoir pressures—together with pressure from overlying rock and seawater—would greatly limit surface expression, should contact with a well or active fault occur. Therefore, appreciable quantities of WST fluids are unlikely to exit the seafloor to the overlying water column. Similarly, release at the seafloor due to cement failure at the injection well would be highly unlikely because pressure detectors would signal well failure and result in termination of WST action.

Conclusions. Under Alternative 1, only negligible impacts on benthic habitats and biota are expected to result under any of the three fracturing WSTs (DFIT, hydraulic fracturing, and acid fracturing) or under the non-fracturing WST (matrix acidizing). The discharge of flowback fluids from acid matrix WSTs would occur infrequently and in small amounts, and acids used in WSTs would be largely neutralized by formation minerals and therefore would produce minimal effects on benthic organisms. The surface discharge of produced water containing WST-related chemicals and waste fluids is also expected to have negligible impact on benthic habitats and biota because of the infrequent discharges of produced water containing WST-related chemicals, the small amounts of WST-related chemicals that would be discharged, the dilution of any WST-related chemicals from the surface discharge point to the seafloor, and the fact that all discharges will be regulated under NPDES permitting, which limits the concentration of discharged WSTs. Properly reinjected produced water containing WST fluids would not impact benthic organisms or habitats. Although accidental seafloor surface expressions could occur with fracturing WSTs, and produced water pipeline leaks with both types of WSTs, such accidents have a very low probability of occurring and are not reasonably foreseeable.

Marine and Coastal Fish.

***WST Operations*.** Under Alternative 1, produced water containing WST fluid constituents can be disposed of through reinjection to a reservoir or through permitted discharge to the ocean after treatment. Reinjected waste fluids will not come in into contact with aquatic biota and is not expected to affect marine and coastal fish. Therefore, the primary potential impacting factor applicable to fish and EFH is the permitted platform discharge of produced water containing WST fluids (Table 4-3). WST fluids can contain biocides, acids, salts, hydrocarbon solvents, and surfactants (Houseworth and Stringfellow 2015), and potential effects from their discharge could include exposure to toxic levels of WST chemicals through direct contact or from ingestion of contaminated food. Similarly, matrix acidizing WSTs may release acids and ammonium compounds, which can be toxic to benthic organisms at high enough doses. For example, at high enough concentrations acids can damage gill tissue, resulting in lethal or sublethal effects, while metals can damage organs and act as neurotoxins.

Despite the potential toxicity of WST fluid constituents (see discussion in Section 4.5.1.2), there is little evidence that prior WST operations on the southern California

OCS have resulted in impacts on fish communities or EFH. Although WST fluids were not specifically examined, studies of fish collected off the California coast indicate contaminant concentrations from fish collected around platforms were low and similar to levels in fish collected from reference areas (Gale et al. 2012; Love et al. 2013). Similarly, Love and Goldberg (2009) found no evidence of significant reproductive impairment in Pacific sanddab (*Citharichthys sordidus*) collected from around platforms on the southern California OCS. Houseworth and Stringfellow (2015) modeled the discharge and dilution of 19 potential WST constituents on marine organisms (including several species of fish) and predicted that only two would exist at concentrations above levels associated with chronic and acute toxicity. However, few of the potential WST fluid constituents could be evaluated due to lack of bioassay data.

Overall, platforms act as artificial reefs and support diverse and productive communities of structure-associated fish. Several studies indicate that the abundance, growth, and productivity of several species of reef fish is higher at Pacific OCS platforms and infrastructure than in nearby natural hardbottom habitat (Love et al. 2003; Love and York 2005; Claisse et al. 2014). This includes those platforms that have practiced hydraulic fracturing. Although these studies do not address the impacts of WSTs directly, they do suggest that oil and gas production activities (including WST use) at the platforms have not been detrimental to fish communities.

***WST-Related Accident Scenarios*.** The accidental release of WST chemicals could occur during vessel delivery, offloading, platform storage, and injection, while the accidental release of produced water containing WST chemicals could occur during collection, platform storage, and pipeline transfer between platforms and to and from onshore processing facilities (Section 4.3). Potential impacting factors that could affect marine and coastal fish are primarily associated with the accidental release of WST chemicals, WST-related fluids, and crude oil (Tables 4-5, 4-7, and 4-9). If an accidental release were to occur, the quantity of WST chemicals released would be small due the quantities of chemicals transported, stored, and used, but it may result in a localized, temporary reduction in water quality.

In an accident resulting in a surface expression (Section 4.3.2), the potential quantities of hydrocarbons or WST fluids exiting the seafloor to the overlying water column would not be expected to have appreciable impacts on marine and coastal fish. The surface expression of biologically significant concentrations of WST fluids is unlikely because real-time pressure monitoring during WST implementation would identify potential contact with wells and an active fault and result in immediate cessation of WST. In addition, existing low reservoir pressures—together with pressure from overlying rock and seawater—would greatly limit surface expression, should contact with an active fault or well occur. Therefore, appreciable quantities of WST fluids are unlikely to reach exit the seafloor to the overlying water column. Similarly, release at the seafloor by cement failure would be highly unlikely because pressure detectors would signal well failure and result in termination of WST action. The accidental release of WST-related chemicals in produced water mixtures would also be expected to have little appreciable effect, owing to the greatly diluted concentrations of WST chemicals that may be in the released produced water mixtures and the subsequent additional dilution that would occur upon release to the ocean.

Overall, given the small quantity of fluids used during a WST and the remote chance of an accidental release of WST-related fluids, the use of WSTs under Alternative 1 is not expected to result in adverse impacts on fish species (including ESA-listed species), or in a loss or modification of EFH.

Conclusions. Under Alternative 1, only negligible impacts on fish and EFH are expected to result under any of the three fracturing WSTs (DFIT, hydraulic fracturing, and acid fracturing) or the non-fracturing WST (matrix acidizing). There is a potential for some individuals to be temporarily exposed to highly diluted concentrations of WST-related chemicals that may be present in produced water being discharged under the NPDES permit, although such discharges (and associated exposures) would occur infrequently and would be localized and of short duration. Because of the anticipated infrequent use of WSTs in the foreseeable future, the infrequent discharge of WST-related waste fluids, the small amounts of WST-related chemicals that would be discharged with any single WST application, and the fact that all discharges will be regulated under NPDES permits, which require the rapid dilution of chemical constituents within the vicinity of the discharge point, impacts on marine and coastal fish and to EFH are expected to be minimal. In addition, acids used in matrix acidizing (a non-fracturing WST) would be largely neutralized by formation minerals and natural seawater buffering, and therefore would have little or effects on fish and EFH. Although accidental seafloor surface expressions could occur with fracturing WSTs, and produced water pipeline leaks with both types of WSTs, such accidents have a very low probability of occurring and are not reasonably foreseeable.

Marine Mammals.

WST Operations**.** Under Alternative 1, the impacting factors potentially affecting marine mammals during use of WSTs are identified in Table 4-3. As with the previous categories of marine biota, potential effects are primarily associated with the discharge from platforms of WST-related fluids and chemicals. Exposure to WST-related chemicals in the discharged waters may occur through direct contact and though ingestion of contaminated food. However, compliance with the requirements of NPDES General Permit CAG280000 will greatly limit the potential for exposure of marine mammals to toxic concentrations of the WST-related chemicals. Because WST fluids are rapidly diluted in the open ocean, marine mammals would be expected to experience only very low levels of exposure from the water column. Acids used by some WSTs undergo chemical reactions downhole and form non-acidic components in the flowback fluids. The acids are also water soluble, so any unreacted acid will be diluted by produced water in the flowback fluids and neutralized by natural seawater buffering following discharge. Thus, WST-related chemicals, including any unreacted acids, will have a negligible impact on marine mammals.

Marine mammals may be indirectly affected if discharges containing WST-related chemicals reduce the abundance of prey species. However, because of the rapid dilution that would occur following permitted discharge, potential impacts on prey populations inhabiting the water column would be limited in extent and would not be expected to affect overall prey abundance. Field studies have shown that the concentrations of trace metals and hydrocarbons in the tissues of fishes around production platforms are within background levels (Continental Shelf Associates 1997). Thus, food chain uptake is not expected to be a major exposure pathway for fish-eating marine mammals at offshore facilities where WSTs are used. As discussed, WSTs are not expected to cause either an acute or a chronic effect on benthic organisms and fish species. Therefore, WSTs are not expected to affect the prey base for marine mammals.

The EPA (2013b), in its issuance of the final NPDES General Permit CAG280000 for discharges from offshore oil and gas facilities located in Federal waters off the coast of southern California, provided an analysis of the potential effects of regulated discharges on several Federally listed marine mammal species. The analysis concluded that no effects are anticipated for the listed marine mammals, primarily because of the very limited time any individuals may spend near a platform (Table 4-18). The EPA (2013b) did not evaluate the Federally endangered North Pacific right whale (*Eubalaena japonica*). However, sightings of this species off the California coast are rare, and there is no evidence that the western coasts of the continental United States were ever highly frequented (Reilly et al. 2008). Thus, no effects are anticipated for this species, largely because there are very few sightings of individuals off southern California and any individuals that may enter the project area would likely spend a very limited amount of time in the vicinity of any of the offshore platforms (Table 3-7).

Noise associated with PSVs used to deliver WST equipment and materials, and with WST activities conducted on the platforms, may have a short-term negligible impact on marine mammals (e.g., localized impact on their behavior and/or distribution). A minor potential exists for marine mammals to be struck by PSVs.

WST-Related Accident Scenarios. Impacting factors associated with accidents during the use of WSTs and affecting marine mammals are identified in Section 4.3. These are associated primarily with accidental releases of WST fluids and waste fluids, and crude oil. Impacts from an accidental release will depend on the magnitude, frequency, location, and date of the release; characteristics of the released materials; spill-response capabilities and timing; and various meteorological and hydrological factors. Impacts could include decreased health, reproductive fitness, and longevity; and increased vulnerability to disease. An accidental release could also lead to the localized reduction, disappearance, or contamination of prey species.

An accident during transport and delivery of WST chemicals (Table 4-4); fluid injection (Table 4-6); or handling, processing, and disposal of WST-related wastes (Table 4-8) could involve the release of WST chemicals to the water column. Impacts of WST constituents released during these activities would be minor due to the relatively small amounts of WST-related materials that could occur followed by the dilution of the released WST-related chemicals (Section 4.5.1.2). In addition, a surface spill during shipping of WST chemicals or during offloading to a platform is expected to have minimal impacts because it is not likely that the entire contents of a shipping container would spill, and the small amount of released fluids would be quickly diluted by the seawater in the area of a spill. Thus, any impacts on marine mammals from the accidental release of WST chemicals or produced water containing WST-related chemicals are expected to be temporary, localized, and affect few if any individuals.

TABLE 4-18 Potential Effects of Regulated Discharges of WST-Related Fluids from Offshore Oil and Gas Facilities on Several Federally Listed Marine Mammals

Species	Status[a]	Potential Effects[b]
Balaenoptera borealis borealis (sei whale—northern hemisphere subspecies)	E/D	No effects anticipated. Individuals spend very limited amounts of time in the vicinity of platforms.
Balaenoptera musculus musculus (blue whale—northern hemisphere subspecies)	E/D	No effects anticipated. Individuals spend very limited amounts of time in the vicinity of platforms.
Balaenoptera physalus physalus (fin whale—northern hemisphere subspecies)	E/D	No effects anticipated. Individuals spend very limited amounts of time in the vicinity of platforms.
Megaptera novaeangliae (humpback whale)	E/D	No effects anticipated. Species not expected to occur in the vicinity of the platforms.
Physeter macrocephalus (sperm whale)	E/D	No effects anticipated. Individuals spend very limited amounts of time in the vicinity of platforms.
Arctocephalus townsendi (guadalupe fur seal)	T/D	No effects anticipated. Species not expected to occur in the vicinity of the platforms.
Enhydra lutris nereis (southern sea otter)	T/D	No effects anticipated. Individuals tend to reside within 1.2 mi of shore, while platforms are 3 mi or more offshore.

[a] Status: E = endangered under the Endangered Species Act (ESA); T = threatened under the ESA; D = depleted under the Marine Mammal Protection Act.

[b] The "no effects" determinations are those provided in the source document.

Source: Modified from EPA (2013b).

An accident from a seafloor surface expression from a fracturing WST (a surface expression is not anticipated for matrix acidizing) would result in only a small release of WST fluids and hydrocarbons (Section 4.5.1.3). Although a surface expression is considered to be of low probability and not reasonably foreseeable, should such a release occur, it is expected to be localized, temporary, and quickly diluted; therefore, impacts on marine mammals would be negligible. Marine mammals may also be affected if containment and cleanup activities for accidental releases are conducted. Marine mammals that may otherwise be unaffected by an accidental release may be affected by increased vessel traffic and remediation activities (Table 4-10). Vessel noise and other factors related to increased human presence would likely cause changes in marine mammal behavior and/or distribution. An increased number of response vessels could also increase the risk for vessel collisions.

Conclusions. Under Alternative 1, only negligible impacts on marine mammals are expected to result under any of the three fracturing WSTs (DFIT, hydraulic fracturing, and acid fracturing) or the non-fracturing WST (matrix acidizing). There is a potential for some individuals to be temporarily exposed to highly diluted concentrations of WST-related chemicals that may be present in produced water being discharged under the NPDES permit, although such discharges (and associated exposures) would occur infrequently and be localized and of short duration. Conduct of any of the WSTs may also result in short-term, localized disturbance in behavior and/or distribution of some individuals, but these impacts would be negligible. Negligible impacts on marine mammals are also expected from accidents related to WSTs. Although accidental seafloor surface expressions could occur with fracturing WSTs, and produced water pipeline leaks with both types of WSTs, such accidents have a very low probability of occurring and are not reasonably foreseeable.

Marine and Coastal Birds.

WST Operations**.** The primary impacting factor potentially affecting marine and coastal birds during WST use is the discharge of WST-related chemicals to the ocean (Table 4-3). Because materials and equipment used for WST operations will be transported to platforms on normal service vessel runs, there will be no additional impacts on birds (e.g., noise or visual disturbances) associated with vessel traffic. Pumps used for WST operations may add to noise disturbances within the immediate area of the platform. The elevated noise levels near a platform from WSTs will be negligible. This is based on only 21 hydraulic fracturing and three matrix acidizing operations reported for Federal platforms between 1992 and 2013 (Long et al. 2015a). The number of WSTs is not expected to vary from these levels in the foreseeable future. At high enough concentrations, WST-related chemicals may be toxic to some marine and coastal birds following exposure through direct contact and through ingestion of contaminated food. Compliance with the discharge requirements of the NPDES General Permit CAG280000 sets spatial limits (328 ft [100 m]) on the concentrations of discharges. Because any discharged produced water containing WST-related chemicals would be rapidly diluted in the open ocean, marine and coastal birds would be expected to experience only very low levels of exposure to contaminants close to a platform. Acids such as HCl and HF undergo chemical reactions downhole that form non-acidic components in the flowback fluids. These acids are also water soluble, so any unreacted acid will be diluted by produced water in the flowback fluids. Thus, the use of acid WSTs are not expected to impact marine and coastal birds.

Marine and coastal birds may be indirectly impacted if WST-related discharges reduce the abundance of prey species. However, because of the rapid dilution that would occur (i.e., NPDES permit limits extend 100 m from the point of discharge), potential impacts on prey populations (see, e.g., previous analysis for marine and coastal fish) would be limited in extent and not expected to adversely affect overall prey abundance. Field studies have shown that the concentrations of trace metals and hydrocarbons in the tissues of fishes around production platforms are within background levels (Continental Shelf Associates 1997). Thus, food chain uptake is not expected to be a major exposure pathway for fish-eating birds at offshore facilities.

Therefore, WST fluids and their constituents are not expected to affect the prey base for marine and coastal birds during WST applications.

The EPA (2013b), in its issuance of a final NPDES General Permit CAG280000 for discharges from offshore oil and gas facilities located in Federal waters off the coast of southern California, provided an analysis of the potential effects of regulated discharges on several of the Federally listed marine and coastal species, including birds. This analysis identified no anticipated effects, primarily because none of the ESA-listed bird species normally occur in the vicinity of the offshore platforms (Table 4-19). As stated in Section 3.5.4.4, the Marbled Murrelet (*Brachyramphus marmoratus*) feeds within 4 mi (7 km) of shore; the largest numbers of this species occur within 2 to 3 mi (3 to 5 km) of shore. Although no mortality of Marbled Murrelets is expected, some individuals may experience short-term disturbance from noise or movement of PSVs. The EPA (2013b) concluded there would be no effects on the California Least Tern (*Sternula antillarum browni*). However, because it feeds up to 2 to 3 mi (3 to 5 km) offshore, with most feeding within 1 mi (1.6 km) of shore, potential disturbance to individuals could occur from PSV traffic associated with WSTs.

Accident Scenarios. A variety of accidents could occur during use of WSTs on the southern California OCS (Section 4.3). Impacting factors associated with such accidents that could potentially affect marine and coastal birds are identified in Tables 4-5, 4-7, and 4-9. These are associated primarily with accidental releases of WST chemicals and fluids, and crude oil. Impacts from an accident depend on the magnitude, frequency, location, and timing of the accident; characteristics of the spilled material; spill-response capabilities and timing; and various meteorological and hydrological factors. Impacts could include decreased health, reproductive fitness, and longevity; increased vulnerability to disease; and increased mortality.

TABLE 4-19 Potential Effects of Regulated Discharge of WST-Related Fluids from Offshore Oil and Gas Facilities on Select Federally Listed Marine and Coastal Birds

Species	Status[a]	Potential Effects[b]
Sterna antillarum browni (California Least Tern)	E	No effects anticipated. Habitat located near coastline or in nearshore shallow waters. Forages within about 2 mi of shore, while platforms are 3 mi or more offshore.
Charadrius nivosus nivosus (Western Snowy Plover)	T	No effects anticipated. Individuals inhabit coastal dunes and beaches, salt pans, and coastline marshes.
Rallus obsoletus levipes (Light-footed Ridgway's Rail)	E	No effects anticipated. Individuals inhabit coastal saltwater marshes and occasionally freshwater marshes.

[a] Status: E = endangered under the Endangered Species Act (ESA); T = threatened under the ESA.

[b] The "no effects" determinations are those provided in the source document.

Source: EPA (2013b).

A spill could also lead to the localized reduction, disappearance, or contamination of prey species. Most accidental releases limited to WST-related chemicals and produced water would quickly dissipate and would only affect a small amount of habitat and relatively few individuals and only for a short time after the release.

An accident at a platform or a PSV could result in the release of WST chemicals to the ocean surface. Although some WST constituents such as acids or biocides are toxic, a surface spill during shipping of WST chemicals by service vessel or during offloading to a platform is expected to have minimal impact because it is not likely that the entire contents of a shipping container would spill, and because of dilution from seawater in the area of a spill. Impacts from the release of WST constituents from a produced water pipeline would also be minimal due to the rapid dilution that would occur (Section 4.5.1.2). Any impacts on marine and coastal birds would be temporary, localized, and affect few if any individuals. However, species such as gulls and shearwaters, which are attracted to offshore platforms or often follow vessels, may be more likely to be exposed to an accidental release. These birds may be directly exposed while feeding or resting in spills originating from platforms or service vessels and could incur lethal or sublethal effects.

An accident from a seafloor surface expression from a fracturing WST (surface expression not anticipated for matrix acidizing) would result in only a small release of WST fluids and hydrocarbons (Section 4.5.1.3). Surface expression would be localized and quickly diluted; therefore, impacts on marine and coastal birds would be negligible. In the event of a seafloor surface expression that includes crude oil, marine and coastal birds may be affected during spill containment and cleanup activities (Table 4-10). Birds that may otherwise be unaffected by an accidental release may be impacted by increased vessel traffic and remediation activities. Vessel noise and other factors related to increased human presence would likely cause changes in seabird behavior and/or distribution. Potential impacts of oil spills and dispersant use are discussed in Section 4.5.1.11.

Conclusions. Under Alternative 1, only negligible impacts on marine and coastal birds are expected to result under any of the three fracturing WSTs (DFIT, hydraulic fracturing, acid fracturing) or the non-fracturing WST (matrix acidizing). Because few fracturing or matrix acidizing WSTs are expected annually at OCS platforms in the foreseeable future, WST operations under Alternative 1 are expected to have no to negligible impacts on year-round resident or seasonally occurring bird species. WST operations would have no impacts on migratory species during the months when such species do not occur in the project area. Otherwise, potential short-term negligible disturbance, mostly from noise or the presence of PSVs, may briefly affect marine and coastal birds. Negligible impacts on marine and coastal birds are also expected from accidental release of WST chemicals. Although accidental seafloor surface expressions could occur with fracturing WSTs, and produced water pipeline leaks with both types of WSTs, such accidents are have a very low probability of occurring and are not reasonably foreseeable.

Sea Turtles.

WST Operations**.** Impacting factors potentially affecting sea turtles during the use of WSTs are identified in Section 4.2.4. Some WST-related chemicals may be toxic to sea turtles, depending on the level and duration of exposure. Exposure may occur through direct contact and though ingestion of contaminated food. Compliance with NPDES permit requirements will greatly limit the exposure of sea turtles to toxic concentrations of WST-related chemicals. Because WST fluids are rapidly diluted in the open ocean, sea turtles would be expected to experience only very low levels of exposure from the water column. Acids, such as HCl and HF, that are used in some WSTs undergo chemical reactions downhole, forming non-acidic components in the flowback fluids. The acids are also water soluble, so any unreacted acid will be diluted by produced water in the flowback fluids. Thus, use of acid WSTs is not expected to impact sea turtles. A minor potential exists for sea turtles to be struck by PSVs used to deliver WST equipment and materials to a platform.

Sea turtles may be indirectly impacted if WST discharges reduce the abundance of prey species. However, because of the rapid dilution that would occur, potential impacts on prey populations inhabiting the water column would be limited in extent and not expected to adversely affect overall prey abundance. Although some WST-related chemicals may reach sediments and reduce macroinfaunal abundance, the potentially affected macroinvertebrate fauna would be generally at depths beyond the diving limits of sea turtles. In addition, concentrations of WST-related chemicals in the discharged water would be further diluted before they would reach the seafloor, and thus be even less likely to affect benthic resources that are utilized by turtles.

The EPA (2013b), in its issuance of a final general NPDES permit for discharges from offshore oil and gas facilities located in Federal waters off the coast of southern California, provided an analysis of the potential effects of regulated discharges on the Federally listed sea turtle species. The EPA concluded that no effects are anticipated for any of the sea turtles as a result of discharges under NPDES General Permit CAG280000 (Table 4-20).

Noise associated with PSVs used to deliver WST equipment and materials, and with WST activities conducted on the platforms, may have a short-term negligible impact on sea turtles (e.g., localized impact on their behavior and/or distribution). A minor potential exists for sea turtles to be struck by PSVs. Because no more than 10 PSV trips would be needed for a WST treatment, and because no more than a few WSTs would be conducted per year at Federal platforms, the likelihood of a sea turtle being struck by a PSV is very low.

WST-Related Accident Scenarios**.** Potential impacting factors that could affect sea turtles are primarily associated with the accidental release of WST fluids and crude oil (Tables 4-5, 4-7, and 4-9). Impacts from an accidental release depend on the magnitude, frequency, location, and date of the release; characteristics of the released material; spill-response capabilities and timing; and various meteorological and hydrological factors. Impacts could include decreased health, reproductive fitness, and longevity; and increased vulnerability to disease. A spill could also lead

TABLE 4-20 Potential Effects of Regulated Discharges of WST-Related Fluids from Offshore Oil and Gas Facilities on Federally Listed Sea Turtles

Species	Status[a]	Potential Effects[b]
Caretta caretta (loggerhead turtle)	E	No effects anticipated. Occurs infrequently near platforms. Discharges from offshore oil platforms not mentioned as a threat to the species.
Chelonia mydas (green turtle)	T	No effects anticipated. Infrequently occurs near platforms. Species mostly occurs outside the project area (south of San Diego). No information found to indicate proposed discharges would affect the species.
Dermochelys coriacea (leatherback turtle)	E	No effects anticipated. Only Platform Irene falls within the area of critical habitat. No information found to indicate proposed discharges would affect the species or its critical habitat.
Lepidochelys olivacea (olive Ridley turtle)	T	No effects anticipated. Rarely occurs near platforms.

[a] Status: E = endangered under the Endangered Species Act (ESA); T = threatened under the Endangered Species Act.

[b] The “no effects” determinations are those provided in the source document.

Source: EPA (2013b).

to the localized reduction, disappearance, or contamination of prey species. Diminished prey abundance and availability may cause sea turtles to move to less-suitable areas and/or to consume less-suitable prey.

A sea surface accident could result in the release of WST chemicals to the ocean. The accidental release of WST-related chemicals in produced water mixtures would also be expected to have little appreciable effect owing to the greatly diluted concentrations of WST chemicals that may be in the released produced water mixtures and the subsequent additional dilution that would occur upon release to the ocean. (Section 4.5.1.2). Although some WST constituents such as acids or biocides are toxic at high enough exposure concentrations, a surface spill during shipping of WST fluids by service vessel or during offloading to a platform is expected to have minimal impact because the entire contents of a shipping container is not likely to spill, and there would be relatively rapid dilution from seawater in the area of a spill. Any impacts on sea turtles would be temporary and localized, and, would affect few if any individuals. Any individuals in the area of a spill would be expected to avoid or leave the spill area, and no population-level effects are expected as a result of an accidental release of WST-related chemical.

An accidental release from a seafloor surface expression during a fracturing WST (which is neither expected nor reasonably foreseeable for any of the WSTs) would result in only a small release of WST fluids and hydrocarbons (Section 4.5.1.3). An accidental seafloor expression is considered to have a very low probability of occurrence and is not reasonably foreseeable. However, should such an accidental release occur, the release of WST chemicals would be localized and quickly diluted. Therefore, impacts on sea turtles would be negligible. In the event of a seafloor surface expression that includes crude oil, sea turtles may be affected during spill containment and cleanup activities (Table 4-10). Sea turtles that may otherwise be unaffected by an accidental release may be affected by increased vessel traffic and remediation activities. Vessel noise and other factors related to increased human presence would likely cause negligible changes in sea turtle behavior and/or distribution. Increased vessel traffic associated with spill response vessels could also increase the risk for vessel collisions. Potential impacts of oil spills and dispersant use are discussed in Section 4.5.1.11.

Conclusions. Under Alternative 1, only negligible impacts on sea turtles are expected to result under any of the three fracturing WSTs (DFIT, hydraulic fracturing, and acid fracturing) or the non-fracturing WST (matrix acidizing). There is a potential for some individuals to be temporarily exposed to highly diluted concentrations of WST-related chemicals that may be present in produced water being discharged under the NPDES permit, although such discharges (and associated exposures) would occur infrequently and would be localized and of short duration. Conduct of any of the WSTs may also result in short-term, localized disturbance in behavior and/or distribution of some individuals, but these impacts would be negligible. Negligible impacts on sea turtles are also expected from accidental release of WST chemicals. Although accidental seafloor surface expressions could occur with fracturing WSTs, and produced water pipeline leaks with both types of WSTs, such accidents have a very low probability of occurring and are not reasonably foreseeable.

4.5.1.5 Recreational and Commercial Fisheries

WST Operations. Under the proposed action, the primary impacting factor affecting commercial and recreational fisheries from WST operations is the permitted platform discharge of produced water containing WST-related chemicals (Table 4-3). Because WST fluids can contain compounds such as biocides, acids, salts, hydrocarbon solvents, and surfactants that can be toxic to invertebrate and fish species (Houseworth and Stringfellow 2015), there is a potential for reductions in the abundance of target species due to localized exposure to toxic levels of WST chemicals in discharges through direct contact or from ingestion of contaminated food.

As discussed in Section 4.2.3, following mixing with produced water, WST waste fluids may be disposed of by reinjection into wells or by permitted discharged from the platforms into the ocean. Waste water that is properly reinjected into subsurface reservoirs would not come into contact with fish and benthic organisms or their habitat and thus not affect fishery resources. The discharge into the ocean of treated wastewater containing WST fluids would be very limited for a number of reasons. First, discharge of wastewater containing WST fluids would occur infrequently, from relatively few platforms. In addition, the discharge of wastewater from platforms on the southern California OCS is regulated by NPDES General Permit CAG280000, which requires that contaminants in the discharged water not exceed concentrations specified in the permit beyond 100 m of the discharge point (see Section 4.5.1.2). As described in Section 4.5.1.2, rapid dilution would be expected over a very short distance from the point of discharge and there would only be a short period of time where marine life or habitats could be exposed and affected. Thus, effects on marine life or habitats from the direct release of WST fluids would be expected to be minor. Consequently, it is anticipated that WST constituents discharged with produced water into the ocean under NPDES General Permit CAG280000 would have negligible effects on fishery species and habitats.

Under Alternative 1, the permitted mixing areas for NPDES permitted discharges would not change from current conditions (i.e., 100 m from the discharge point). Consequently, there would be no additional restrictions on areas available for fishing compared to current conditions.

It is anticipated that WST fluids and WST activities would not result in increases in platform vessel traffic compared to current conditions. As a consequence, preclusion from fishing areas due to interference with WST supply vessels is not expected to differ from levels experienced during existing routine operations.

WST-Related Accident Scenarios. Under Alternative 1, the accidental release of WST chemicals could occur during vessel delivery, offloading, platform storage, and injection (Section 4.3). In addition, the accidental release of produced water containing WST constituents could occur during collection, platform storage, and pipeline transfer of produced water (Section 4.3.3). If large quantities of WST chemicals were released during such accidents, there is a potential for localized and temporary closure of fisheries because of potential contamination, or because of a reduction in abundance of fishing resources (i.e., fish/invertebrates) due to lethal or sublethal effects following exposure to toxic levels of the released WST chemicals. There would also be a potential for localized and temporary closure of fishery areas during cleanup operations in the event of accidents resulting in releases of large quantities of WST chemicals or fluids (Table 4-10).

As of July 2015, there had been no reported spills of WST chemicals or fluids (Houseworth and Stringfellow 2015) associated with offshore activities in California, and an accidental release by the mechanisms identified above is considered very unlikely. If an accidental release were to occur, it is anticipated that the quantity of WST chemicals released would be relatively small and quickly diluted to acceptable (nontoxic) levels, although localized, temporary reductions in water quality could occur (see Section 4.5.1.2). As a consequence, adverse impacts on species or habitats important for recreational or commercial fisheries are considered unlikely.

Conclusions. Under Alternative 1, only negligible impacts on recreational or commercial fisheries are expected to result under any of the three fracturing WSTs (DFIT, hydraulic fracturing, and acid fracturing) or the non-fracturing WST (matrix acidizing). The discharge of flowback fluids from acid matrix WSTs would occur infrequently and in small amounts, and acids used in matrix acidizing WSTs would be largely neutralized by formation minerals and therefore would produce minimal effects on area fisheries. The surface discharge of produced water containing WST-related chemicals and waste fluids is also expected to have negligible impacts on fisheries resources because of the infrequent discharges of produced water containing WST-related chemicals, the small amounts of WST-related chemicals that would be discharged, the dilution of any WST-related chemicals from the surface discharge point to the seafloor, and the fact that all discharges will be regulated under NPDES permitting, which limits the concentration of discharged WSTs. Properly reinjected produced water containing WST fluids would have no impact on fisheries resources. Although accidental seafloor surface expressions could occur with fracturing WSTs, and produced water pipeline leaks with both types of WSTs, such accidents have a very low probability of occurring and are not reasonably foreseeable.

4.5.1.6 Areas of Special Concern

WST Operations. Under Alternative 1, areas of special concern (see Section 3.11) may be affected by WST operations if the permitted discharge of produced water containing WST-related chemicals were to affect the water quality at the area of special concern (Table 4-3). However, such effects are highly unlikely. Both the EPA (2010) and the California Coastal Commission (2013) contend that discharges (including those containing WST-related chemicals) from platforms on the southern California OCS authorized by the NPDES General Permit CAG280000 will not cause significant degradation of the marine environment and are consistent with the marine protection and water quality policies of the California Coastal Act (California Coastal Commission 2013). Discharges will not compromise the biological productivity of coastal waters or inhibit the maintenance of optimum populations of marine organisms as required by Sections 30230 and 30231of the California Coastal Act (California Coastal Commission 2013). The NPDES General Permit CAG280000 provides protection against contamination expected from hydrocarbons and produced water that may contain WST-related chemicals.

Because of the distance of the 23 platforms on the southern California OCS from any areas of special concern, permitted discharges at the platforms are not expected to affect water quality of any areas of special concern, and thus would not affect the purpose or use of those areas. For example, the nearest platform to any of the areas of special concern is Platform Gail. This platform is about 3,600 ft (1,100 m) from the outer boundary of the Channel Islands Marine Sanctuary; this sanctuary is a 6-nautical mi^2 (11-km^2) area surrounding the Channel Islands National Park (Section 3.7.1). Based on these distances, the dilution and natural breakdown of WST constituents following their permitted discharge in produced water should preclude any impacts on water quality at the sanctuary or the national park, as well as associated Marine Protected Areas. Similarly, the various State-protected areas (e.g., marine reserves, marine conservation areas, and special closure areas; Figure 3-19) would also not be affected by WSTs, primarily due to their distance from the platforms on the southern California OCS.

A variety of military use areas and activities occur in the Pacific Ocean off of southern California (Section 3.11.6). The OCS platforms are located either within Military Warning Areas or between the Military Warning Areas and the coast. A Military Warning Area is airspace of defined dimensions, extending from 12 nautical mi (22 km) outward from the coast of the

United States, containing activity that may be hazardous to nonparticipating aircraft. Use of these air spaces would not be affected by WST operations. This is also the case for the Point Mugu Sea Range. U.S. Navy and Marine amphibious training along the coast would not be affected by WST operations. The Vandenberg Air Force Base is located in the area of the more northern OCS platforms (Irene, Hidalgo, Harvest, and Hermosa). These platforms are several nautical miles offshore from the base; therefore, WSTs would not affect the base or interfere with its operations. WSTs would not affect either danger zones (water areas used for target practice, bombing, rocket firing, or other especially hazardous operations, normally for the armed forces) or restricted areas (water areas designated for the purpose of prohibiting or limiting public access in order to provide security for government property and/or protection to the public from the risks of damage or injury arising from the government's use of that area).

WST-Related Accident Scenarios. Accidents associated with WST use would only affect areas of special concern if accidentally released WST chemicals or crude oil were to affect the water quality, biota, and other resources that underlay the special concern status of the area, or preclude the intended purpose or use of the area (e.g., conservation of fish and wildlife, military training). The likelihood of an accidental release affecting the purpose or use of an area is remote. Any accidental surface releases of WST chemicals during delivery, platform storage, and injection (which have a low probability of occurring and may or may not be reasonably foreseeable [see Section 4.3]) would be small in size and would stay in the immediate vicinity of the platform. Any such small spills would be rapidly diluted and chemical constituents would be degraded; coupled with the distances between platforms and the areas of special concern, such small spills would not be expected to affect water quality, biota, and other aspects of the areas of special concern.

Although not reasonably foreseeable, a seafloor surface expression could include the release of crude oil, which would not be expected to undergo dilution or degradation to the same extent as WST fluid constituents. Should the crude oil reach an area of special concern, it could impact water quality and biota at the area, as well affect the purpose and use of that area.

Conclusions. Routine WST operations involving either fracturing or matrix acidizing will have no impacts on areas of special concern. No impacts on areas of special concern are also expected from accidental releases of WST fluids.

4.5.1.7 Archaeological Resources

WST Operations. As discussed in Chapter 3, cultural resources include submerged prehistoric archaeological sites and historic shipwrecks, as well as coastal prehistoric sites and architectural resources found onshore. Because WST operations would include no new onshore or offshore construction, there would be no seafloor or ground disturbing activities that could affect known or unknown archaeological resources in the area.

WST-Related Accident Scenarios. The accidental release of WST chemicals is not expected to have any effects on known or unknown archaeological or historic resources in the area. Dilution and degradation of any released WST chemicals in seawater would remove any corrosive properties of the chemicals, effectively exposing archaeological or historic resources to seawater. The greatest potential for effects on such resources would be associated, not with contact with WST chemicals or crude oil (if released during a seafloor surface expression or well casing failure), but rather with physical damage that may occur during response activities addressing the release (Bittner 1996; Reger et al. 2000).

Conclusions. No impacts on archaeological resources are expected to result under any of the three fracturing WSTs (DFIT, hydraulic fracturing, acid fracturing) or the non-fracturing WST (matrix acidizing) under Alternative 1. Should there be a release of crude oil as a result of an accidental seafloor surface expression or a well casing failure during WST injection, response activities could damage some resources. All response activities would be overseen and directed by the U.S. Coast Guard, which would be expected to consider potential impacts of selected response actions on archeological resources. However, such accidental releases have a very low probability of occurrence and are not reasonably foreseeable.

4.5.1.8 Recreation and Tourism

WST Operations. Recreation and tourism together are a major economic driver in the four coastal counties adjacent to the southern California OCS. WST operations would have no or negligible impacts on ecological resources (Section 4.5.1.4), recreational and commercial fisheries (Section 4.5.1.5), or areas of special concern (Section 4.5.1.6); thus, no impacts on recreation and tourism (including aesthetic impacts) related to WST use are anticipated. A typical WST may occur over the course of several days and the visual character of the site where the work is performed would be largely unchanged from its pre-stimulation condition (Aspen Environmental Group 2015). No additional service vessel trips are expected that could result in a visual or noise annoyance to tourists or recreationists, or in space-use conflicts with recreational fishermen. The discharge and mixing zone currently in place for the permitted discharge of wastewater (including produced water) would not change with the use of WSTs, and thus should not affect recreational activities in the vicinity of the platforms. Truck traffic into Port Hueneme to deliver extra chemical totes, pumps, or other equipment necessary for WST operations is not expected to noticeably increase traffic in the area.

WST-Related Accident Scenarios. Among the accident scenarios identified for WST use, accidental surface releases of WST chemicals at platforms during delivery, platform storage, and injection (which have a low probability of occurring but some of which are reasonably foreseeable [see Section 4.3]) would be small in size and would stay in the immediate vicinity of the platform. Any such small spills would be rapidly diluted and chemical constituents would be degraded; coupled with the distances between platforms and areas used for recreation and tourism, such small spills would not be expected to affect activities associated with recreation and tourism. More substantive impacts would occur if crude oil was associated with a seafloor surface expression or a well casing failure (see Section 4.5.1.11); however, such accidents are very unlikely to occur and are not reasonably foreseeable.

Conclusions. Under Alternative 1, the proposed action, **t**he use of fracturing (DFIT, hydraulic fracturing, and acid fracturing) or the non-fracturing WST (matrix acidizing) is not expected to impact any areas of special concern. No impacts on areas of special concern are expected from accidental releases of WST fluids.

4.5.1.9 Environmental Justice

WST Operations. The environmental justice impact analysis evaluates the potential for disproportionately high and adverse human health and environmental effects on minority and low-income populations that could result from WST use at the platforms on the southern California OCS. The use of WSTs is not expected to result in any adverse effects on minority and low-income populations. All WST operations would use existing infrastructure and facilities, would occur on already operating platforms, and would dispose of WST-related fluids in the same manner as currently used for wastewater disposal at the platforms (either reinjection or NPDES-permitted discharge). Truck traffic into Port Hueneme to deliver extra chemical totes, pumps, or other equipment necessary for WST operations will not be noticeably different from existing traffic levels. The permitted discharge of produced water containing WST-related chemicals is also not expected to affect any resources providing subsistence or recreational use to any area populations, including low-income or minority populations. Therefore, there will be no disproportionately high adverse health or environmental effects on minority or low-income populations from WSTs.

WST-Related Accident Scenarios. Accidents associated with WSTs may cause a localized decrease in water quality, which could reduce use of impacted areas by every ethnicity and income level, including minority and low-income populations. However, the amount of WST chemicals released would be quickly diluted in close proximity to a release. No disproportionate effects on minority and low-income populations are expected from offshore WST-related accidents.

Coastal areas will not be affected by an accidental release of WST constituents (in the event of a seafloor surface expression from a fracturing WST). An accidental release of crude oil (in the event of a seafloor expression), discussed in Section 4.5.1.11, is not likely to be of sufficient magnitude or duration to have an adverse and disproportionate long-term effect on low-income and minority communities in the four coastal counties of southern California. Although low-income and minority populations reside in some areas of the coast, in general coasts in southern California are home to more affluent groups. Thus, low-income and minority groups are less likely to bear more negative impacts than other groups.

Conclusions. Under Alternative 1, the proposed action, **t**he use of fracturing (DFIT, hydraulic fracturing, and acid fracturing) or the non-fracturing WST (matrix acidizing) is not expected to impact minority or low-income populations. Similarly, no impacts are expected from accidental releases of WST fluids. No environmental justice impacts are expected from accidental releases of WST fluids.

4.5.1.10 Socioeconomics

WST Operations. Under Alternative 1, the use of WSTs is not expected to affect employment, income, State and local tax revenues, population growth, housing, or community and social services. Any WST activities would be conducted with no increase in the workforce, using the existing workforce at the platforms and on service vessels. Because delivery of WST materials to platforms and the return of proppants and comingled fracturing fluids and produced water would make use of existing vessels and/or pipelines, no new land-based or transportation systems would be required. Because an increased workforce is not anticipated, there would be no effect on employment, income, State and local tax revenues, population, housing community, or social services. Although the use of WST fluids and materials (e.g., proppants) could benefit suppliers of these materials, WST use is expected to be very infrequent (based on past WST activity at platforms on the southern California OCS; see Table 4-1) and thus is not expected to provide more than very minor and localized economic benefits for area businesses.

WST-Related Accident Scenarios. Unlike an oil spill, an accidental release of WST chemicals will quickly dilute and degrade by natural processes. Therefore, even a large release of WST chemicals (which is not reasonably foreseeable) is not be expected to cause a loss of employment, income, and property values; increased traffic congestion; increased cost of public service provision; or possible shortages of commodities or services. There could also be a temporary cessation of oil and gas production at the platform associated with the accidental release and subsequent cleanup. There may be short-term expenditures and an increase in the number of individuals employed if cleanup and remediation activities are required. This would be considered a short-term negligible impact.

Conclusions. Under Alternative 1, the proposed action, **t**he use of fracturing (DFIT, hydraulic fracturing, and acid fracturing) or the non-fracturing WST (matrix acidizing) is not expected to result in socioeconomic impacts. No negligible socioeconomic impacts are expected from any of the accident scenarios considered for Alternative 1, because the accidents have low probabilities of occurrence, and with the exception of a localized crane accident occurring at a platform, are not reasonably foreseeable.

4.5.1.11 Cumulative Impacts

A cumulative impact, as defined by the Council on Environmental Quality, "results from the incremental impact of [an] action when added to other past, present, and reasonably foreseeable future actions, regardless of what agency (Federal or nonfederal) or person undertakes such other actions" (40 CFR 1508.7). Repeated actions, even minor ones, may produce significant impacts over time through additive or interactive (synergistic) processes. The baseline environment for the proposed action (as described in Chapter 3), and the direct and indirect impacts that could result with implementation of any of the WSTs included in Alternative 1 (Sections 4.5.1.1 through 4.5.1.14) account for the past and present actions in the project area. The impacts identified for Alternative 1 are carried forward to the cumulative impact analysis, which also takes into account the effects of other ongoing and reasonably foreseeable future actions and trends.

A variety of past, current, and reasonably foreseeable future activities and actions contribute to cumulative impacts on the natural resources potentially affected by the use of WSTs under the proposed action, including air, water, benthic communities, fish, sea turtles, birds, and marine mammals, and also on socioeconomic and sociocultural conditions, including environmental justice and recreational and commercial fisheries in the potentially affected portions of the southern California OCS. These other activities include, but are not limited to, oil and gas development and production activities in Federal and State waters as well as onshore; runoff from onshore industries, agriculture, transportation (fossil fuel combustion products), urban development, and sewage treatment plant discharges; commercial and recreational fishing; commercial and recreational vessel traffic; and recreation and tourism. Potential effects of these other activities may impact air and water quality, marine and coastal habitats and biota, socioeconomics (including commercial and recreational fisheries, and recreation and tourism), and have environmental justice concerns. In addition, natural phenomena such as certain weather events (e.g., El Niño events), as well as climate change, may also impact resources and socioeconomic/sociocultural conditions on the southern California OCS and adjacent areas. The nature, extent, and magnitude of any of these anthropogenic and non-anthropogenic activities and events will vary widely, depending on the causative activity or event and its location, duration, and magnitude.

Under Alternative 1, the use of any of the four WSTs included in the alternative is expected to have at most only limited or negligible impacts on potentially affected resources. Any impacts that might result under Alternative 1 are expected to be temporary, localized, and because of the anticipated limited use of WSTs under this alternative, infrequent. Thus, impacts from the implementation of Alternative 1 are not expected to result in any measurable increases in cumulative effects on resources or socioeconomic/sociocultural conditions of the project area.

4.5.2 Alternative 2—Allow Use of WSTs with Depth Stipulation

Under Alternative 2, BSEE technical staff and subject matter experts would continue to review APDs and APMs involving the use of any of the WSTs included in the proposed action and, if determined to be compliant with the performance standards identified in BSEE regulations at 30 CFR 250, subpart D, would be approved. However, applications for fracturing WST use at depths less than 2,000 ft (610 m) below the seafloor would not be approved without further environmental evaluation and review. This limit is intended to reduce the possibility of a surface expression occurring during a fracturing treatment below the already low possibility of such an event occurring under Alternative 1. All other operational aspects and assumptions identified for Alternative 1 would apply to this alternative.

4.5.2.1 WST Operations

The effects of WST operations under Alternative 2 would be the same as those described for Alternative 1, in that the quantity and nature of WST use would be mostly the same. The use of any of the WSTs under this alternative would result in only small or negligible impacts on air quality, water quality, benthic resources, marine and coastal fish, EFH, sea turtles, marine and coastal birds, marine mammals, areas of special concern, archaeological resources, recreation and tourism, or socioeconomics. The use of fracturing WSTs under this alternative is also not expected to increase the potential for induced seismic events. No disproportionate impacts are expected on minority and low-income populations under this alternative.

4.5.2.2 WST-Related Accident Scenarios

As under Alternative 1, there is a low likelihood (i.e., very low probability of occurrence and not reasonably foreseeable) of an accidental seafloor release of crude oil and WST fluids due to subsurface expression under Alternative 2. The likelihood of an accidental seafloor release would be even less than under Alternative 1 due to the depth restriction under Alternative 2. Restricting hydraulic fracturing depths to deeper than 2,000 ft (610 m) would increase the length of any release pathway to the surface, and greater overlying formation and hydrostatic pressures that would occur under Alternative 2 would further act to suppress seafloor surface expression. Thus the potential for exposure to WST-related chemicals and released hydrocarbons due to an accidental seafloor expression would be reduced compared to Alternative 1. It is unlikely, however, that permits would be approved for WST use at shallow depths in areas with a high potential for the presence of existing faults that reach the seafloor or wells under Alternative 1 in the absence of a depth stipulation; therefore, actual differences between the two alternatives would likely be small with respect to the likelihood of a seafloor release during a fracturing WST. Alternative 2 provides an additional safety buffer in the event of an unknown fault or less well-known area.

There would be no differences between Alternative 2 and the proposed action in the potential for, and effects from, surface accidents during collection, platform storage, and pipeline transfer between platforms and to and from onshore processing facilities. Effects of such accidents would depend on the specific factors and characteristics of the accident, as described for Alternative 1.

4.5.2.3 Cumulative Impacts

The actions affecting resources and socioeconomic and sociocultural conditions in the project area, as described in Section 4.5.1.11 for Alternative 1, would continue for Alternative 2. The potential cumulative contribution of Alternative 2 to impacts affecting resources in the area will be similar to those described for Alternative 1, and could be somewhat less due to the reduced potential for an accidental seafloor surface expression with the depth restriction of Alternative 2. The contribution of WSTs to cumulative impacts of Alternative 2 in the region would be the same as identified for Alternative 1. Under Alternative 2, the contributions are considered to be negligible compared to the contributions from other sources that affect resources or socioeconomic and sociocultural conditions in the area.

4.5.3 Alternative 3—Allow Use of WSTs with No Open Ocean Discharge of WST Fluids

Under Alternative 3, APDs and APMs that include the use of any of the four WST types included in the proposed action would continue to be reviewed by BSEE technical staff and subject matter experts, and, if determined to be compliant with the performance standards identified in BSEE regulations at 30 CFR 250, subpart D, would be approved. However, in contrast with Alternatives 1 and 2, under Alternative 3 there would be no open ocean disposal of any fluids containing WST-associated chemicals. This restriction is intended to eliminate all potential impacts associated with the exposure of marine biota and habitats to surface water discharges containing WST constituents, which are currently permitted under NPDES General Permit CAG280000 and be allowed under Alternatives 1 and 2. Open ocean discharge of produced water and other operational fluids, as permitted under the NPDES general permit would continue under Alternative 3.

4.5.3.1 WST Operations

Under Alternative 3, potential impacts of WST use would be identical to those identified for Alternatives 1 and 2, with one exception. The prohibition of open ocean discharge of WST fluids under Alternative 3 would eliminate exposure to WST chemicals in surface water discharges and any impacts associated with such exposures by benthic resources, marine and coastal fish, EFH, marine and coastal birds, sea turtles, marine mammals, and commercial and recreational fisheries. Such discharges would be allowed under Alternatives 1 and 2 under NPDES General Permit CAG280000.

Some platforms on the Federal OCS currently dispose of produced water via onshore or offshore injection (Table 4-2), and it is assumed that any produced water containing WST-related chemicals would be disposed of in a similar manner. At these platforms, no reduction in potential exposure of marine resources to produced water containing WST chemicals would be expected, while potential impacts identified from other aspects of WST use (e.g., localized and temporary reductions in air quality) for Alternative 1 would also be possible under Alternative 3.

At platforms where disposal of produced water does not involve either onshore or offshore injection (see Table 4-2), the injection of WST-bearing produced water would eliminate the exposure of marine biota and habitats to WST chemicals and any possible toxic effects of such exposures (see Sections 4.1.5.4 to 4.5.1.8). Due to the potential need to drill additional injection wells at these platforms, Alternative 3 may have some impacts that would not occur under Alternatives 1 or 2, namely impacts from the construction of new injection wells. Disturbance of the seafloor from drilling injection wells could temporarily and locally impact water quality and thereby affect benthic resources and fish, either due to sediment disturbance or from the discharge of drill cuttings. Localized disturbance of seafloor habitats for benthic resources and fish would also be expected where new injection wells are drilled. In addition, marine fish, birds, and mammals, as well as sea turtles, could be disturbed by noise during drilling of additional injection wells. Air quality could be temporarily affected from emissions from drilling rigs. Any such impacts associated with drilling new injection wells would be localized and short term, and would not be expected to result in long-term impacts on air or water quality, or on marine habitats and biota. Under Alternative 3, platform operators may incur some additional costs associated with the disposal of WST waste fluids, especially if a new injection well is deemed necessary.

4.5.3.2 WST-Related Accident Scenarios

The restriction against open ocean discharge of any WST-related fluids would not affect the potential for WST-related accidents. The potential likelihood for an accidental release of WST-related chemicals, as well as any associated impacts, would be the same under Alternative 3 as those identified for Alternative 2 for all WSTs.

4.5.3.3 Cumulative Impacts

The actions affecting resources and socioeconomic and sociocultural conditions in the project area, as described in Section 4.5.1.11 for Alternative 1, would continue to affect the project area under Alternative 3. The contribution of WSTs to cumulative impacts of Alternative 3 in the region would be the same as identified for Alternative 1; contributions would be considered negligible compared to the contributions from other sources that affect resources and socioeconomic and sociocultural conditions in the area. However, because there would be no open water discharge of WST-related chemicals and wastes under Alternative 3, there would be a very slight decrease in potential cumulative impacts associated with open water discharge. Although the construction of a small number (if any) of new injection wells would locally impact some resources, any such impacts would be very localized and short term, and not expected to appreciably contribute to impacts incurred by affected resources from other sources. Potential contributions to cumulative impacts from accidental releases would be negligible.

4.5.4 Alternative 4 No Action—No WST Use on Existing OCS Leases

Under the Alternative 4 No Action, none of the WST types identified for the proposed action would be approved for use in any current or future wells on the production platforms associated with the 43 active leases on the southern California OCS. Drilling, production, well workover, and routine maintenance activities on the platforms and their wells would continue under Alternative 4. BSEE technical staff and subject matter experts would continue to review APDs and APMs and, if determined to be compliant with the performance standards identified in BSEE regulations at 30 CFR 250 Subpart D, these would be approved. However, no APDs or APMs that include a WST would be approved.

4.5.4.1 Operations Excluding WSTs

None of the effects on resources identified under Alternative 1, the proposed action, as specifically associated with WST operations, would be expected to occur under Alternative 4. Oil and gas drilling and production activities would continue, including the permitted discharge of produced water and other operational discharges under the NPDES general permit. The prohibition of WSTs on existing OCS leases would have no effect on the hazard of induced seismicity relative to Alternative 1, because the hazard of induced seismicity associated with the injection of WST-generated fluids is considered to be low already (Section 4.5.1).

Under this alternative, routine oil and gas activities, such as PSV traffic and produced water waste handling and disposal, would continue to occur (as they would under each of the other three alternatives). In addition, the conduct of routine well cleaning operations, and use of enhanced oil recovery treatments (such as steam flooding), would also continue to be reviewed for approval by BSEE technical staff and subject matter experts under this alternative as they would be under the other three alternatives. Routine well cleaning operations include the use of acid or solvent treatments, water blasting, and casing scrape/surge (see Section 2.2.5).

Routine well cleaning operations using acid treatments have been conducted as needed at wells on the Pacific OCS and at wells in State waters (Houseworth and Stringfellow 2015), and there is no evidence of these treatments having resulted in any adverse environmental impacts. Acid washes are conducted on wells in the Pacific OCS on average once every other year for a given well (Kaiser 2016). Acid solutions used for routine well cleaning are similar in type (e.g., HCl, HCl-HF) and concentration (typically 15% or lower) to those used in the acid-based WSTs (see Section 2.2.1), although the volume of acid solution used for an acid wash is much less than that used for a WST. The volume used for an acid wash will depend on the length of the interval undergoing the wash, and may range from 5,000 to 10,000 gal (119 to 238 bbl). In contrast, as much as 240,000 gal (5,700 bbl) of acid solution would be used in completing a four-stage acid fracturing or matrix acidizing WST application (60,000 gal [1,430 bbl] per stage). California SB-4 WST regulations call for the calculation of an Acid Volume Threshold (AVT) to distinguish acid matrix stimulation treatments from the routine use of acids (14 CCR §1761), and the volume of acid solution used at a well for an acid wash would be much less than the calculated AVT for that well.

The effects of acid treatments for well maintenance would be somewhat similar to, but of much lower magnitude than, those for matrix acidizing or acid fracturing, which use much larger volumes of acid. In an acid wash, following injection the acid solution is allowed to remain in place to dissolve wellbore damage, during which time the acid becomes neutralized. Upon return to the surface, the wash-related fluids are managed as specified in the waste management plan and are processed accordingly. Any open-water discharges containing acid wash fluids would need to meet the requirements of the NPDES general permit before discharge would occur. Because of the small volume of acid solution used for well maintenance, any partially neutralized acid would be fully neutralized when combined and treated with other wastewater, or rapidly diluted and neutralized within the NPDES mixing zone if discharged directly to the ocean. Fluids associated with a solvent wash would be collected, handled, and disposed of in an appropriate manner in accordance with the waste management plan. Any residuals discharged in wastewater would be quickly diluted and would meet the requirements of NPDES-permitted open-water discharge. Acid and solvent washes are conducted about once every other year for any particular well, so discharges of wash-related chemicals would occur infrequently and would be of very short duration. Thus, the use of acid washes for routine well cleanup is not expected to result in any adverse environmental impacts on the Pacific OCS.

Solvent washes are also low-volume well cleaning procedures that may occur once every other year at a well. Typically, the solvent wash volume is in the range of 2,500 to 5,000 gallons (60 to 119 bbl), depending on the interval length undergoing cleaning. Solvents and other fluids collected during any of the four well maintenance activities are handled in accordance with approved waste management plans for the platforms. Any disposal of any such fluids by open-water discharge would be conducted in compliance with the requirements of the NPDES general permit for the OCS platforms. Thus, the use of solvent washes for routine well cleanup is not expected to result in any adverse environmental impacts on the Pacific OCS.

Water blasting uses a high-pressure spray of filtered seawater to dislodge sand, scale, corrosion particles, built-up sludges, and other materials that may be inhibiting flow of oil into the well. With water blasting, no acid solutions or solvents are used, and the pressure used for blasting is well below that required for formation fracturing. Water volumes for this well cleaning operation may range from 1,000 to 5,000 gallons (24 to 119 bbl), depending on the interval length and the specific type of pressure/jet wash being employed (Kaiser 2016). Water blasting operations generate relatively little waste, on the order of a few cubic yards of debris (e.g., sand scale, corrosion particles), and these wastes are collected on the platform and containerized for transport to shore for disposal (Kaiser 2016).

Depending on the type of water blasting being used, wash water containing dislodged deposits may or may not be returned to the surface (i.e., to the platform). If returned, the wash waters are collected and screened to remove solid deposits, which are containerized and then transported to shore for disposal, while the wastewater (primarily seawater) is recycled for additional use in well cleanup operations, or disposed of per the waste management plan. Wash waters not immediately returned would be treated as ordinary well fluids. Ocean discharge of any wastewater would meet NPDES permit requirements. Thus, the use of water blasting for routine well cleanup is not expected to result in any adverse environmental impacts on the Pacific OCS.

Casing scrape/surge involves the mechanical removal of scale, corrosion particles, sludge, and other materials without any application of acid solutions or solvents. Relatively little waste (on the order of a few cubic yards of solid debris) is generated, and these wastes are containerized on the platform and transported to shore for disposal. Any wastewater collected during this operation would be handled per the waste management plan, and waste liquids meeting the requirements of the NPDES general permit could be discharged to the open ocean. Because there is no open-water disposal of solid waste materials, and wastewater would only be discharged if NPDES permit requirements are met, the use of casing scrape/surge for well maintenance is not expected to result in any environmental impacts.

With respect to potential effects other than those related to routine well maintenance operations, under Alternative 4, there would be no disproportionate effects on minority and low-income populations related to the prohibition of WST use on the southern California OCS. However, a prohibition of offshore WST use may lead to additional onshore use of WSTs, which could have adverse environmental justice impacts (Aspen Environmental Group 2015).

Potential WST-related socioeconomic impacts for Alternative 4 would be associated with the potential closure of wells that become unproductive and could benefit from the implementation of a WST (i.e., WST use may prolong oil production), but are prohibited from doing so. This could lead to drilling of additional wells offshore and/or onshore, earlier-than-expected decommissioning of platforms, and/or increased importation of oil and gas from elsewhere in the United States or from foreign sources. These would have potentially major economic consequences that are beyond the scope of this EA. However, an earlier-than-expected closure of wells and platform decommissioning is not expected in the foreseeable future.

4.5.4.2 Accident Scenarios Excluding WSTs

None of the WST-related accident scenarios identified for Alternative 1 would be expected under Alternative 4, and thus none of the potential WST accident-specific effects on resources identified under Alternative 1 would be expected to occur under Alternative 4. As for anticipated accidental releases during the transfer of acids from PSVs to the platforms or on platforms during WSTs, which are considered reasonably foreseeable but unlikely (see Section 4.3), similar reasonably foreseeable but unlikely accidental releases of acids and solvents could occur during acid and solvent wash well cleaning operations. Such releases may affect water quality as well as marine biota in the immediate vicinity of the release. However, any accidental releases would be of much smaller volumes than those of accidental releases associated with WSTs. In the event of an accidental release during an acid or solvent wash operation, the release would be of small volume and duration, would be quickly diluted, and thus would result in negligible impacts.

4.5.4.3 Cumulative Impacts

The actions affecting resources and socioeconomic and sociocultural conditions in the project area, as described in Section 4.5.1.11 for Alternative 1, would continue to affect the project area under Alternative 4. There would be no potential direct cumulative contribution of WSTs under Alternative 4 because there would be no WST use. If no WSTs are allowed, the possibility exists that the lifespan of the existing offshore oil wells on the southern California OCS may be shortened (although not in the foreseeable future), and the maximum practical production of oil and gas from the reservoirs under the OCS would be less.

Implementation of Alternative 4 may necessitate the drilling and production of new wells offshore and/or onshore, increase WST use at onshore wells, and/or increase the need to import more gas and oil. These would all increase environmental and societal cumulative impacts. For example, increased use of WSTs at onshore sites may have environmental justice impacts and increase the potential for induced seismicity hazards (Aspen Environmental Group 2015). The prohibition on the use of the WSTs under Alternative 4 may also increase domestic production of electricity using generation alternatives such as coal or alternative energy (e.g., solar and wind). Because the mix of other energy sources and locations are unknown, it is too speculative to discuss their cumulative impacts.

4.6 SUMMARY OF ENVIRONMENTAL EFFECTS

The use of WSTs at platforms on the Federal OCS has the potential to affect a variety of resources. Given the type and the expected frequency of use of WST activities that are reasonably foreseeable for the Federal OCS, none of the three action alternatives are expected to result in adverse impacts on the environment (Table 4-21). While an accidental release of WST chemicals during conduct of a WST may also affect a variety of resources, all three alternatives have a similarly low and not reasonably foreseeable potential for the accidental releases of WST-related chemicals (Table 4-22). During WST implementation, Alternatives 1–3 would have only very small, localized, and temporary effects on air and water quality, while Alternatives 1 and 2 also have the potential for some marine biota to be exposed to highly diluted concentrations of WST chemicals in the NPDES mixing zones of platforms following NPDES-permitted open water discharge. Additional localized and temporary impacts on air and water quality, marine biota, and archaeological resources could be incurred under Alternative 3 (Table 4-21). These additional impacts would be associated with the construction of any new injection wells that may be needed as a result of the prohibition of open water discharge of produced water containing WST-related chemicals. Overall, there are relatively few differences among the action alternatives (or between fracturing and non-fracturing WSTs) regarding the nature and magnitude of the environmental effects (Table 4-21), which remain small under any of the action alternatives.

Under Alternative 3, there would be no open water discharge of WST waste fluids. As a result, operators at platforms may have to install offshore injection wells in order to dispose of any produced water containing WST chemicals or waste fluids. Such activities would include localized, temporary bottom-disturbing activities. Well drilling would disturb seafloor habitats, potentially affect seafloor archaeological artifacts, reduce overlying water quality, and disturb local biota. The operation of associated surface support vessels and equipment would result in increased air emissions and also disturb local biota. Platform operators would also incur additional costs with any new injection well construction.

1 **TABLE 4-21 Summary Comparison of Potential Effects among Alternatives[a]**

Resource	Alternative 1 Proposed Action – Allow Use of WSTs	Alternative 2 – Allow Use of WSTs with Depth Stipulation	Alternative 3 – Allow Use of WSTs with No Open Water Discharge of WST Fluids	Alternative 4 – No WST Use on Existing OCS Leases
Air quality	No noticeable WST-related impacts on regional air quality expected. Negligible emissions of greenhouse gases.	Same as Alternative 1.	Same as Alternative 1. Additional temporary and localized air emissions if new injection well construction occurs.	No WST-related impacts.
Water quality	No WST-related impacts expected; although slight localized reduction in water quality at surface water discharge location.	Same as Alternative 1.	Similar to Alternative 1, but no reductions in water quality from WST chemicals in discharges to surface water. Temporary and localized reduction in water quality if new injection well construction occurs.	No WST-related impacts.
Induced seismicity	Very low or negligible potential for induced seismicity.	Same as Alternative 1.	Same as Alternative 1.	Same as Alternative 1.
Benthic resources	No WST-related impacts expected.	Same as Alternative 1.	Same as Alternative 1. Localized and temporary benthic habitat disturbance likely if new injection well construction occurs.	No WST-related impacts.
Marine and coastal fish; sea turtles, marine and coastal birds, marine mammals	No WST-related impacts expected; potential for subtle toxic effects in some species from some WST chemicals occurring within the NPDES discharge mixing zone from discharges of WST waste fluids to surface water.	Same as Alternative 1.	Similar to Alternative 1, but with no potential for exposure to WST chemicals in discharges to surface water. Localized and temporary habitat disturbance and/or displacement of individuals likely if new injection well construction occurs.	No WST-related impacts.

2

TABLE 4-21 (Cont.)

Resource	Alternative 1 Proposed Action – Allow Use of WSTs	Alternative 2 – Allow Use of WSTs with Depth Stipulation	Alternative 3 – Allow Use of WSTs with No Open Water Discharge of WST Fluids	Alternative 4 – No WST Use on Existing OCS Leases
Commercial and recreational fisheries	No WST-related impacts expected.	Same as Alternative 1.	Same as Alternative 1. Localized and temporary habitat disturbance and/or displacement of individuals likely if new injection well construction occurs.	No WST-related impacts.
Areas of special concern, recreation and tourism, archaeological resources, environmental justice	No WST-related impacts expected.	Same as Alternative 1.	Same as Alternative 1. Localized and temporary habitat disturbance and/or displacement of individuals likely if new injection well construction occurs.	No WST-related impacts.
Socioeconomics	No WST-related impacts or benefits expected.	Same as Alternative 1.	Same as Alternative 1. Platform operators may incur additional costs if new injection wells are needed.	No WST-related impacts. Decommissioning costs may be incurred at some wells that become unproductive in the absence of WST use.

[a] A comparison of the likelihood of various accidents under the alternatives is provided in Table 4-22.

None of the potential effects associated with WST use (including waste disposal) identified for Alternatives 1–3 would be expected under Alternative 4. In contrast to Alternatives 1–3, Alternative 4 may have economic effects associated with the decommissioning of wells that become unproductive in the absence of WST use.

Because WSTs on the OCS would be conducted in accordance with all BSEE, BOEM, and other regulatory agency rules and regulations dealing with safety and spill response, the probability for an accidental release to occur is low and reasonably foreseeable for only a single accident scenario considered in this EA (i.e., during the transfer by crane of WST chemicals from a PSV to a platform). All other accident scenarios were identified to have a low or very low probability of occurring and not reasonably foreseeable. With regard to reducing the likelihood of a WST-related accident occurring, there is relatively little difference among the three action alternatives (Table 4-22). However, Alternative 2 differs from the other WST alternatives with regard to reducing the risk of an accidental seafloor surface expression during WST fluid injection. The depth stipulation of this alternative may even further decrease the likelihood of a surface expression of hydrocarbons should a fracture contact an existing pathway (e.g., a surface fault) to the surface. Such a seafloor expression is considered to be a very low probability event

TABLE 4-22 Comparison of Likelihood of Occurrence of WST-Related Accidents among Alternatives

	Likelihood			
Accident	Alternative 1 Proposed Action – Allow Use of WSTs	Alternative 2 – Allow Use of WSTs with Depth Stipulation	Alternative 3 – Allow Use of WSTs with No Open Water Discharge of WST Fluids	Alternative 4 – No WST Use on Existing OCS Leases
WST chemical release during transport following loss of transport container integrity	Applicable to all four WST types. Very low probability and not reasonably foreseeable.	Same as Alternative 1.	Same as Alternative 1.	Will not occur.
WST chemical release during crane transfer	Applicable to all four WST types. Low probability and reasonably foreseeable.	Same as Alternative 1.	Same as Alternative 1.	Will not occur.
WST chemical release during injection from platform equipment malfunction	Applicable to all four WST types. Low probability and reasonably foreseeable.	Same as Alternative 1.	Same as Alternative 1.	Will not occur.
Seafloor expression of WST chemicals due to well casing failure	Applicable only to fracturing WSTs. Very low probability and not reasonably foreseeable.	Same as Alternative 1.	Same as Alternative 1.	Will not occur.
Seafloor expression of WST chemicals due to fracture intercept with existing surface pathway	Applicable only to fracturing WSTs. Very low probability and not reasonably foreseeable.	Reduced probability compared to Alternative 1.	Same as Alternative 1.	Will not occur.
Release of WST chemicals due to rupture of pipeline conveying produced water containing WST chemicals	Applicable to all WSTs. Very low probability and not reasonably foreseeable.	Same as Alternative 1.	Same as Alternative 1.	Will not occur.

and not reasonably foreseeable under any of the action alternatives to begin with, and even less so under Alternative 2 (Table 4-22). None of the WST-related accident scenarios could be realized under Alternative 4.

In conclusion, neither the proposed action nor any of the action alternatives are expected to result in more than short-term, localized impacts on the environment. Potential impacts of WST use would be similar in nature and magnitude among the action alternatives, although Alternative 3 would reduce potential exposure of marine biota to WST-related chemicals in surface water. Compared to the other action alternatives, Alternative 3 would also have some additional localized and temporary impacts should construction of new injection wells be needed for disposal of produced water containing WST-related chemicals. With the exception of a crane accident resulting in the release of WST chemicals at a platform, the other accident scenarios that could result in the release of WST chemicals are considered to be unlikely and not reasonably foreseeable for the three action alternatives, while Alternative 2 has the potential to further reduce the already very low likelihood of an accidental release of WST chemical via a seafloor surface expression.

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5 LIST OF PREPARERS

Table 5-1 presents information on the preparers of the *Draft Programmatic Environmental Assessment of the Use of Well Stimulation Treatments on the Southern California Outer Continental Shelf*. The list of preparers is organized by agency or organization, and information is provided on education, experience, and contribution to the EA.

TABLE 5-1 List of Preparers

Name	Education/Experience	Contribution
Bureau of Environmental Safety and Enforcement		
Olivia Adrian	B.A. Management, M.S. Public Administration; Level III, Certified Contracts Manager, Supervisory Program Manager, and Chief of Contract Support Section; 30 years of experience in contract support and management	Project management support; subject matter expert coordination
John Ajak	B.S. Petroleum and Natural Gas Engineering, M.Sc. Engineering Management; BSEE Headquarters general engineer with the Emerging Technologies Branch; 9 years in the oil and gas industry	Subject matter expert
Chuck Barbee	B.S. Government, M.A. Organizational Management; BSEE Regional Environmental Officer; 32 years of experience in environmental compliance, preparedness, and response in multiple disciplines	NEPA subject matter expert; technical expertise, support, and review
David Fish	B.A. International Relations, M.A. Public Policy. BSEE Senior Advisor and Acting Chief, Environmental Compliance Division; 32 years of experience in safety and environmental preparedness, response, and enforcement including Federal On-Scene Coordinator for the U.S. Coast Guard and BSEE	BSEE Project Manager; subject matter expert; technical expertise, support, and review
John Kaiser	B.S. Petroleum Engineering, M.S. Petroleum Engineering; BSEE Acting District Manager, California District, Well Operations Lead; 35-year member Society of Petroleum Engineers (section Officer); IADC and API certifications	Subject matter expert in well operations, stimulation, and completion

TABLE 5-1 (Cont.)

Name	Education/Experience	Contribution
John Keith	B.S. Applied Science, M.S. Systems Management; BSEE Acting Regional Director, Pacific Region; 32 years of experience in natural resource management	Technical expertise, support, and review; project management support
Drew Mayerson	B.S. Geology; BSEE Pacific Regional Supervisor, Office of Production and Development; 31 years of experience in offshore California geology	Subject matter expert; technical review
Nabil Masri	B.A. Geology, M.S. Petroleum Engineering; BSEE Regional Supervisor, Office of Field Operations, Pacific Outer Continental Shelf Region; 38 years of experience in regulatory oil and gas operations	Technical review
Nathan Sinkula	B.S.E. Chemical Engineering; BSEE Petroleum Engineer, Office of Production and Development, Pacific Outer Continental Shelf Region; 7 years of experience in reservoir engineering	Technical review and support
Mohammad Ashfaq	B.S. Petroleum and Natural Gas Engineering; BSEE Regional Operations Section, Pacific Region; 6 years of experience in oil and gas engineering, research and development, and project management	Subject matter expert; technical support and review
Bureau of Ocean Energy Management		
David Panzer	B.S. Oceanography, B.A. Zoology; BOEM Chief, Environmental Analysis Section, Pacific Region; 30 years of experience in environmental assessment and NEPA	NEPA; technical expertise, support, and review
Richard Yarde	B.S. Wildlife Science, M.S. Renewable Natural Resource Studies, J.D.; BOEM Pacific Regional Supervisor, Office of Environment	BOEM Project Manager; general document and process support
Susan Zaleski	B.A. Biology, M.S. Marine Biology; Biological Oceanographer; 15 years of experience in environmental assessment	Subject matter expert and coordinator; technical review

TABLE 5-1 (Cont.)

Name	Education/Experience	Contribution
Argonne National Laboratory		
Young Soo Chang	Ph.D. Chemical Engineering; 24 years of experience in air quality and noise impact analysis	Air quality
Mark Grippo	Ph.D. Biology; 9 years of experience in aquatic resource studies and impact analysis	Benthic resources; marine and coastal fish; essential fish habitat
Christopher Harto	B.S. Chemical Engineering, M.S. Sustainability; 6 years of experience in energy and environmental analysis	WST technology descriptions
John Hayse	Ph.D. Zoology; 27 years of experience in ecological research and environmental assessment	Recreational and commercial fisheries
Ihor Hlohowskyj	Ph.D. Zoology; 37 years of experience in ecological research; 35 years in environmental assessment	Argonne Project Manager; purpose and need, proposed action, and alternatives; accident scenarios
Patricia Hollopeter	B.A. Religion, M.A. Philosophy; 30 years of experience editing technical communication products	Technical editor
Louis Martino	M.S. Environmental Toxicology; 38 years of experience in environmental remediation and assessment	WST technology descriptions; technical review
Daniel O'Rourke	B.A. History and Anthropology, M.S. Industrial Archeology; 19 years of experience in archaeology	Archaeological resources
Terri Patton	M.S. Geology; 26 years of experience in environmental research and assessment	Geologic resources; seismicity; areas of concern; recreation and tourism
Kurt Picel	Ph.D. Environmental Health Sciences; 36 years of experience in environmental health analysis; 20 years in environmental assessment	Assistant Project Manager; proposed action and alternatives; water quality
Pamela Richmond	M.S. Computer Information Systems; 17 years of experience in Web site development and related technology	Public website development

TABLE 5-1 (Cont.)

Name	Education/Experience	Contribution
Carolyn Steele	B.S. English, B.S. Rhetoric; 10 years of experience in technical editing	Lead technical editor
William Vinikour	M.S. Biology with environmental emphasis; 38 years of experience in ecological research and environmental assessment	Marine mammals; marine and coastal birds; sea turtles; listed species; socioeconomics; environmental justice; cumulative impacts
Emily Zvolanek	B.A. Environmental Science; 6 years of experience in GIS mapping	Technical lead for GIS mapping and analysis